PROJECT SPECIFICATIONS

(Volume 1 of 1)

PROJECT NO. DGS C-0503-0026 PHASE 1

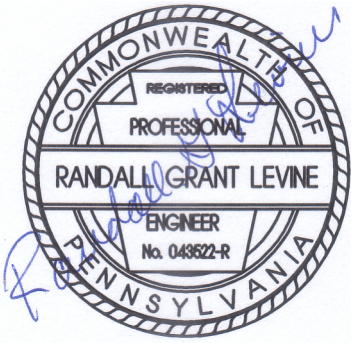
Contract No. DGS C-0503-0026 Phase 1.1 – General Construction
Contract No. DGS C-0503-0026 Phase 1.2 – HVAC Construction
Contract No. DGS C-0503-0026 Phase 1.3 – Plumbing Construction
Contract No. DGS C-0503-0026 Phase 1.4 – Electrical Construction

For

HVAC Upgrades to Green and Reed Buildings
Danville State Hospital – North Central Secure Treatment Unit
Danville, Montour County, PA

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

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



Date: November 07, 2024

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DIVISION 26 ELECTRICAL

LIST OF DRAWINGS

NUMBER AND TITLE OF DRAWINGS

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GENERAL CONSTRUCTION CONTRACT (DGS 0503-0026 Phase 1.1)

ARCHITECTURAL

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HVAC CONSTRUCTION CONTRACT (DGS 503-23 Phase 1.2)

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E-5	Electrical Schedules – Green Building
E-6	Schedules and Details – Green Building
E-7	Basement Plan – Reed Building - Electrical

The Professional, when directed by the Department, will furnish from time to time, as the work progresses, such supplemental drawings as may be required for further illustrating the details of the work, but these supplemental drawings will not include the shop drawings, all of which are to be prepared by the contractor and submitted as specified for approval before the work is started.

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. Danville State Hospital (NCSTU Reed and Green Buildings) – Danville, PA

1.3 CONTRACT DURATION

A. The Construction Contract duration shall be 399 calendar days commencing on the date of the Initial Job Conference.

B. Refer to Section 013100 for how the contract duration may be impacted by long lead-time materials and equipment.

1.4 PROJECT DESCRIPTION

A. Green Building No. 8 HVAC

The new design is utilizing energy efficient, split DX air handling units with hot water heating coils and outdoor ground located condensing units. The separation and re-zoning of the air handling units provides a level of redundancy if equipment failure occurs, are more accessible, and easier to replace in the future. A majority of the existing insulated ductwork is being reused. New mechanical space(s) are created on each floor to support the new HVAC design. Electrical power is provided to support the respective new HVAC systems and related equipment. New valves, refrigerant piping, filters, heating coils, cooling coils, strainers, piping, piping supports, temperature controls and any other equipment required for a fully functional HVAC system are provided. Outdoor HVAC equipment is located at ground level to reduce weather damage, have safe access for maintenance staff, and have accessibility for future replacement. The new HVAC design includes the replacement of the aging hot water heating equipment located in the basement mechanical room of Green Building. The new hot water heating system improves efficiency and serviceability. The campus continues to provide steam to Green building for conversion to hot water. Electrical power is provided to support the

respective new heating systems and related equipment. The existing building fire alarm system is also modified due to the amount of HVAC renovations. All areas of the building being served by new HVAC systems receive new automatic temperature controls (ATC) that are fully integrated into the existing automatic temperature control system located in the Administration Building No.13. The flat roof over the existing kitchen and dining areas will also be removed and replaced as part of this project.

B. Reed Building No. 12 HVAC

All the existing HVAC equipment such as heating radiators, pumps, heat exchangers, ventilation units, exhaust fans, expansion tanks, air separators, valves, piping, piping supports, piping insulation, and pneumatic temperature controls are being replaced in the two main mechanical rooms in the basement of Reed Building. The pneumatic controls and air compressors are removed, and new Direct Digital Controls are being provided. The new temperature control system is fully integrated to the existing automatic temperature control system located in Administration Building No.13.

C. Green Building No. 8 and Reed Building No. 12 Miscellaneous Improvements:

- There are miscellaneous modifications to walls, doors, windows, etc.
- There are miscellaneous modifications to other building systems including sprinkler, plumbing, lighting, power, fire alarm, video surveillance, security, data/telephone/cable TV cabling, etc.

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)

1. Green building - remove ceiling tiles and grids in corridors. Provide new grids and re-install ceiling tiles.
2. Green building – provide new ceiling, flooring, and paint in basement computer lounge.
3. Green building – provide new ceilings in additional basement spaces such as salon, corridor, gym, billiards, cardio, and kitchen.
4. Green building – replace flat roof above kitchen/dining area.

C. HVAC CONSTRUCTION (.2)

1. Green building – replace (4) ex. indoor split AHUs and provide (4) new indoor split AHUs for a total of (8) AHUs. Install condensing units on grade.

2. Green building – provide new indoor split AHU to serve basement area.
3. Green building – provide split system and ERUs to serve Gym and Computer Classroom in basement.
2. Green building – replace supply duct mains in corridors.
3. Green building – replace all air terminals on first and second floors.
4. Green building – provide all new Distech controls throughout building.
5. Green building – replace ex. heat exchangers, pumps, condensate receiver pump, expansion tank, valves, and associated piping.
6. Green building – provide exhaust fans for all toilet and shower rooms.
7. Reed building – replace ex. heat exchangers, pumps, condensate receiver pumps, expansion tanks, valves, and associated piping.
8. Reed building – remove ex. pneumatic control system and upgrade to all new Distech controls throughout the building.
11. Provide all required testing, adjusting, and balancing.

D. PLUMBING CONSTRUCTION (.3)

1. Green building – replace ex. domestic hot water heater, piping, and accessories.
2. Green building – provide condensate piping for all (9) AHUs.
3. Reed building – replace ex. domestic hot water heater, piping, and accessories.

E. ELECTRICAL CONSTRUCTION (.4)

1. Temporarily disconnect and remove existing light fixtures in areas as depicted on architectural and electrical plans for ceiling grid replacement.
2. Disconnect and remove all existing fire alarm initiation and notification devices, wiring, conduits, surface raceways, fire alarm control and notification appliance panels.
3. Disconnect electrical to HVAC equipment scheduled to be demolished.
4. Disconnect and save for reuse existing ceiling mounted CCTV, paging speakers and exit sign devices in areas as depicted on architectural and electrical plans for ceiling grid replacement.
5. Reinstall existing removed light fixtures in new ceiling grid systems.
6. Reinstall existing removed CCTV, paging speakers and exit sign devices in new ceiling grid systems. Provide all new wiring to all devices (new, existing and relocated) in building.
7. Provide duct detectors and fire alarm connections to new sprinkler flow and tamper switches.
8. Provide interior 120/208V distribution system to feed HVAC equipment panelboards.
9. Provide electrical branch circuits to all new HVAC equipment.
10. Provide complete building fire alarm system replacement consisting of fire alarm panel, fire alarm NAC panels, fire alarm remote annunciators, components, initiation and notification devices, wiring and programming. (Green Building Only).

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 10 and Divisions 31 and 32.

C. HVAC Construction (.2) Contract: Divisions 01 and 23 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25, 31, and 32.

D. Plumbing Construction (.3) Contract: Divisions 01, 21, 22 and applicable Sections of Divisions 02, 03, 05, 07, 09, 21, 25, 31, and 32.

E. Electrical Construction (.4) Contract: Divisions 01 and 26 and applicable Sections of 02, 03, 07, 08, 31, and 32.

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

1.7 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.

HVAC CONSTRUCTION (.2) CONTRACT – SCHEDULE OF UNIT PRICES			
ITEM NO.	DESCRIPTION	UNIT OF MEASUREMENT	QUANTITY IN LUMP SUM BID
1	TSI Pipe Insulation – Mag Pipe Insulation (Basement Boiler Room Corridor in Green Building)	SF	250
2	Mudded Pipe Fitting (Basement in Green Building)	QTY	50

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. HVAC Construction (.2) Contract:

1. Unit Price 1: TSI Pipe Insulation – Mag Pipe Insulation (White), Basement Boiler Room Corridor in Green Building, 250 SF.
2. Unit Price 2: Mudded Pipe Fitting, Basement in Green Building, Quantity of 50.

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 0503-0026 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, as Base Bid No. 1 work.
        a. Provide new doors and finishes for new mechanical rooms in Green Building
        b. Remove and re-install ceiling grid system to accommodate new ductwork installation on 1st and 2nd floors in Green Building.
        c. Install new ceiling system in Green Building basement lounge.
        d. Remove and re-install ceiling grid system to accommodate new ductwork installation in additional scope areas of Green Building (Gym, salon, corridor, billiards, cardio, and kitchen).
        e. Completely remove and replace flat roof above dining and kitchen area of Green Building.

2. Base Bid No. 2:

    a. Same as Base Bid No. 1

3. Base Bid No. 3:

    a. Same as Base Bid No. 2

B. HVAC CONSTRUCTION CONTRACT (DGS 0503-0026 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, as Base Bid No. 1 work.
    a. Replace (4) ex. Split air handling units in Green Building with (8) new split air handling units for better load distribution and temperature control.
    b. Provide new duct tie-ins as required to achieve the heating and cooling system separation.
    c. Replace/upgrade controls as required.
    d. Provide a replacement hot water heating distribution system in the basement of Green Building.
    e. Provide HVAC for new classroom in basement of Green Building.
    f. Provide HVAC for existing gym in basement of Green Building.
    g. Provide new split air handling unit to serve Green Building basement.

2. Base Bid No. 2:

a. Same as Base Bid No. 1, except add – all work in mechanical room 0012 of the Reed building and complete controls replacement and upgrade of the pneumatic control system.

3. Base Bid No. 3:

a. Same as Base Bid No. 2, except add – all work in mechanical room 0025 of the Reed building.

C. PLUMBING CONSTRUCTION CONTRACT (DGS 0503-0026 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, as Base Bid No. 1 work.
    a. Replacement of ex. Domestic steam to hot water generator.
    b. Condensate work to support HVAC changes.
    c. Miscellaneous fire protection changes throughout Green Building.

2. Base Bid No. 2:

a. Same as Base Bid No. 1, except add – all work in mechanical room 0012 of the Reed building.

3. Base Bid No. 3:

a. Same as Base Bid No. 2, except add – all work in mechanical room 0025 of the Reed building.

D. ELECTRICAL CONSTRUCTION CONTRACT (DGS 0503-0026 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, as Base Bid No. 1 work.
   a. Work to support the HVAC changes in Green building.
   b. Replacement of the fire alarm system in Green building.

2. Base Bid No. 2:

a. Same as Base Bid No. 1, except add – all work in mechanical room 0012 of the Reed building and fire alarm system upgrade/replacement at Reed building.

3. Base Bid No. 3:

a. Same as Base Bid No. 2, except add – all work in mechanical room 0025 of the Reed building and fire alarm system upgrade/replacement at Reed building.

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 503-23 PHASE 1.1 General Construction

B. DGS 503-23 PHASE 1.2 HVAC Construction (Lead Contractor)

C. DGS 503-23 PHASE 1.3 Plumbing Construction

D. DGS 503-23 PHASE 1.4 Electrical Construction

1.4 VISIT TO SITE

A. Access to the site will be restricted to the pre-bid site visit.

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 engaged in 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 Control in the 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 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 Contactor shall implement corrective actions to protect workers, other building occupants, and to prevent the disturbance of mold in affected areas. Although not presently regulated by EPA and/or OSHA, the EPA does provide industry standards regarding worker safety and abatement procedures, which are the minimum procedures to be followed if mold is encountered.

B. Any mold that appears as a result of construction shall be abated immediately by the Contractor responsible for this condition. The affected surface shall be cleaned, removed, and replaced. Inspection and testing shall be done by a qualified testing agency to confirm the mold has been removed in its entirety.

1.8 TESTING OF EQUIPMENT

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

1.9 INSTRUCTIONS AND TRAINING

A. Refer to General Conditions Section 6.50 and 6.51, as specified in the applicable technical portion of each specification for "Operations and Maintenance Instruction Manuals" and "As-Built Drawing" requirements.

B. Unless approved by the Department, training shall not be scheduled/conducted until As-Built 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 video tapes 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 video taped by the Contractor. The video tape(s) are to be given to the Department.

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.

1.10 PROJECT SIGN

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

1.11 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.

1.12 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.

1.13 WORKING HOURS

A. The Contractor's available working hours shall be from 7:00 A.M. to 5:00 P.M., Monday through Friday.

B. Work during different hours, or work on Saturdays, Sundays, State and National Holidays or overtime work, must have the Using Agency’s prior written approval. After receiving the Using Agency’s approval, the regional director or his designee shall provide written approval.

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.

E. Utility shut-downs required for tie-ins to existing systems shall be done in off-hours, weekends, and/or holidays to minimize the impact on the operations of the Client Agencies (and/ or surrounding buildings). These costs shall be anticipated and included in the Contractor's bid. Contractors are to follow all requirements stated in Articles 6.21 and 6.22 of the General Conditions and submit the "Utility Shutdown Checklist" form accessed through the eBuilder Forms Module for approval. Forms are located under the Project Menu along the left column of eBuilder. The "Utility Shutdown Checklist" form is listed under Workflow Forms within the "All Workflow and Static Forms" drop-down menu.

1.14 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 should 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.

1.15 PARKING

A. Parking shall be limited to areas indicated on the Site Plans. All parking is subject to prior approval of the Department, Using Agency, and Danville State Hospital campus.

1.16 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 Institution’s operation. This plan is subject to the Department’s and the Using 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.

1.17 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 Geotechnical Report and exhibits are available to Bidders at the office of the Professional, upon signature of a standard form of receipt, whereby the Bidder acknowledges and understands that the information in the Report is for the purpose of designing the Project only, is 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.

1.18 SITE FENCE

A. The existing security fence shall remain secure for the duration of the project. Any section of fence removed during a day of construction must be re-installed and re-secured by the end of that working day. The Using Agency shall inspect the fence to ensure it adheres to the security standards of the facility.

1.19 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 General Conditions Section 6.38.

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.

Northcentral Regional Office
208 West 3rd Street
Williamsport, Pa. 17701
(717) 327-3636

Counties: Bradford, Cameron, Clearfield, Centre, Clinton, Columbia, Lycoming, Montour, Northumberland, Potter, Snyder, Sullivan, Tioga, and Union

1.20 OFFICE FOR CONTRACTOR

A. The 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 and telephone service.

1.21 DGS CONSTRUCTION MANAGER OFFICE

A. 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, etc. to provide a fully integrated and functioning system.

IT Hardware/Peripherals:
8. __2__ Computer monitor(s) - basis of design - Hewlett Packard ProDisplay P232 - 23"
9. __2__ Keyboard - basis of design - Hewlett Packard KU-1156
10. __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.
11. __2__ Mouse - optical mouse with USB cord, dual button and scroll wheel – Basis of design - Hewlett Packard

1. Location of the DGS Construction Manager Office shall be the Montour Building #4 First Floor, Office (Room#1001) and the Meeting Room (Room# 1032).

1.22 SANITARY FACILITIES

A. General Conditions Section 19.4 is hereby deleted. The following conditions shall pertain:

1. Sanitary facilities will, within the limitations of the existing facilities, be provided by the Client Agency at no cost. The Lead Contractor shall provide all supplies and maintain the facilities in a clean and sanitary manner at all times.

2. The existing facilities available for the Contractor's use will be assigned by the Department at the Initial Job Conference.

1.23 SMOKING POLICY

A. Smoking and use of smokeless-tobacco are strictly prohibited in all buildings.

1.24 CONCRETE AND EARTHWORK

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

1.25 QUALITY CONTROL TESTING

A. Structural-related testing and inspections required to be performed by the Contractor(s) are listed in Section 01400 – Quality Control Testing Services. If Quality Control testing or inspections required appear in Section 01400 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 01400, they shall be required as if specified in Section 01400. 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 01401 – Quality Assurance Testing and Inspection Services.

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

1.26 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.

1.27 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.
   i. Deferred design submissions for L&I approval
      1. Fire Alarm
      2. Sprinkler Drawings

1.28 COORDINATION DRAWINGS

A. General:

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

B. Coordination Procedures:

1. The HVAC Contractor shall have the lead role in this process and shall initiate Coordination Drawings by producing background drawings in electronic format. Electronic drawing files will be available in e-Builder to all Prime Contractors. These background drawings shall include walls, partitions,

structural elements, finished floor elevations, dimensions, ductwork, piping, conduit, system devices, associated equipment, etc.

2. Electronic drawings shall then be forwarded to the other Prime Contractors, one at a time, including the General Contractor, for inclusion, layout and interface of all relative equipment, material and penetrations associated with the Work.
3. Each Prime Contractor is responsible for the accuracy and completeness of all Coordination Drawings and shall review all other Prime Contractor's drawings so that there will be no interference and/or conflict with its portion of the work.
4. Upon completion of the preliminary Coordination Drawings, the HVAC Contractor shall schedule a coordination meeting with all Prime Contractors in order to resolve all interference issues. Altering structural elements, bearing elevations, established dimensions, partition locations and ceiling/bulkhead heights or any other aesthetic effect is prohibited without the consent of the Professional.
5. Upon resolution of all interference issues, the Coordination Drawings shall be revised as required, and upon acceptance by all Prime Contractors, the HVAC Contractor will upload the final Coordination Drawings to e-Builder.

    a. Coordination Drawings shall contain a signature block for each Prime Contractor to provide signatures and dates indicating concurrence.

6. Coordination Drawings may be formulated and submitted in partial submittals to facilitate the construction schedule and sequence of work within the Project. This must be agreed to by all Prime Contractors and a priority of sequence must be established that has the concurrence of all parties, including the Department. Approval of partial sets of Coordination Drawings shall not relieve the Contractors of their responsibility for properly coordinating work appearing in subsequent submissions. Any revisions to subsequent work necessitated by such partial approvals shall be performed at no additional cost to the Department.

C. Coordination of Work:

1. Each Prime Contractor shall clearly show, and coordinate with the other Prime Contractors, the following:

    a. Arrange for pipe spaces, chases, slots, sleeves, and openings with general construction work, and arrange in building structure during progress of the Work, to allow for and facilitate distribution line and equipment installation.
    b. Coordinate installation of required supporting devices for ductwork, piping, and conduit, as well as sleeves, and other structural components, as they are constructed.

c. Coordinate requirements for access panels and doors for HVAC, Plumbing and Electrical items requiring access where concealed behind finished surfaces.
d. Coordinate electrical connections to equipment provided by all Contractors.
e. Sequence, coordinate, and integrate installing materials and equipment for efficient flow of the Work. Coordinate installing large items of equipment requiring positioning before closing in the building.

2. Each Prime Contractor shall coordinate its construction operations with those of other Prime Contractors and entities to ensure efficient and orderly installation for each part of the Work. Each Prime Contractor shall coordinate its operations with other operations, included in different Sections that depend on each other for proper installations, connection, and operation. All Prime Contractors shall:

   a. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   b. Coordinate installation of all components with other Prime Contractors to ensure adequate accessibility/clearance for required maintenance and service.
   c. Make provisions to accommodate items scheduled for later installation.

1.26 DOMESTIC STEEL

A. Products furnished under this contract shall comply with the Pennsylvania "Steel Product Procurement Act, of 1978, P.L.6, Number 3" including the 1984 and all subsequent amendments.

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. It shall be noted that the following is a basic overview of the Milestones, and that the construction sequencing drawings shall be referenced for further detail and clarification:

1. GENERAL CONSTRUCTION (.1)

a. Initial job conference.
b. Mobilization.
c. Removal and reinstallation of ceilings and installation of new ceilings.
d. Work to support new mechanical rooms.
e. Roof replacement over Green Building kitchen area.
f. Final inspection.

2. HVAC CONSTRUCTION (.2)

   a. Initial job conference.
   b. Mobilization
   c. Removal of existing air handling, condensing units, ductwork, and air terminals.
   d. Installation of new air handling units in Green Building.
   e. Installation of new ductwork and air terminals.
   f. Installation of replacement pumps, heat exchangers, and piping in Green Building.
   g. Testing, adjusting, and balancing of new systems.
   h. Removal of existing pumps, heat exchangers, piping, and accessories in Reed Building.
   i. Installation of replacement pumps, heat exchangers, piping, and accessories in Reed Building.
   j. Testing, adjusting, and balancing of new systems.
   k. Final inspection.

3. PLUMBING CONSTRUCTION (.3)

   a. Initial job conference.
   b. Mobilization.
   c. Removal of existing domestic hot water heater in Green Building.
   d. Installation of replacement domestic hot water heater in Green Building.
   e. Removal of existing domestic hot water heater in Reed Building.
   f. Installation of replacement domestic hot water heaters in Reed Building.
   g. Final inspection.

4. ELECTRICAL CONSTRUCTION (.4)

   a. Initial job conference.
   b. Mobilization.
   c. Removal of existing electrical apparatus in ceilings.
   d. Completion of electrical branch circuits to all new HVAC equipment.
   e. Completion of new electrical apparatus in ceilings.
   f. Fire alarm system upgrade/replacement.
   g. Inspections.
   h. Final inspection.

1.5 SEQUENCING OF CONSTRUCTION AND OTHER REQUIREMENTS

A. It shall be noted that the following is a basic overview of the sequencing, and that the construction sequencing drawings shall be referenced for further detail and clarification.
   a. One wing (roof down to basement) will be vacated per sequence. It is the responsibility of the Client Agency (7 business days allocated) to relocate residents and prepare areas where residents will be relocated to. The preparation of these areas shall be in accordance with the facilities security standards. The Client Agency shall relocate all furniture (except for stationery equipment) from each wing per sequence prior to the contractors mobilizing in that particular wing. Upon completion of each sequence, the Client Agency (7 business days allocated) is responsible for moving all furniture back into the area. The Client Agency is required to conduct a final inspection to ensure all bedrooms, classrooms, offices, and ancillary spaces meet or exceed the facility security standards.
   b. The contractors shall adhere to the facility standards for on-site construction. The existing security camera system shall remain fully functional for the duration of the project. The wing and associated floors under construction shall be locked down for the duration of the sequence. All contractors are subject to security clearance and inventory of tools upon entering the building at the discretion of the facility. Tools and equipment left within the project area shall be stored in a lockable enclosure within the locked down wing. Any necessary work to be completed outside of the area of sequence shall be coordinated with the facility.

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

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 01401. 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 structure(s) and soils.

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, the BOC Inspector Supervisor, the BOC Field Inspector, and the Contractor, with additional copies directly to any governing authority when that authority so directs. All reports shall be submitted within 24 hours of when the inspection, test 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
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. Compressive Strength of Cylindrical Concrete Specimens	ASTM C143, C1064, C231 or C173 or C138, C172, C31 C39	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.
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
Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	ACI 530	Continuous
STRUCTURAL STEEL		
High Strength Bolting	AISC ASD or LRFD M2.5	Comply with current requirements of RCSC
Liquid Penetrant Examination	ASTM E165	Test 15% of critical field welds using _____ method **[to be specified by structural engineer herein]**
Guide for Magnetic Particle Examination	*ASTM E709*	
Practice for Ultrasonic Contact Examination of Weldments	ASTM E164	
Guide for Radiographic Examination	ASTM E94	

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 01400.

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.

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 AND INSPECTIONS

REQ'D BY[1]	DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	IBC REFERENCE[2]
	CONCRETE		
IBC	1. Inspection of reinforcing steel, including prestressing tendons, and placement	ACI 318: 3.5, 7.1-7.7	1913.4
IBC	2. Inspection of reinforcing steel welding, in accordance with Table 1704.3, Item 5b	AWS D1.4; ACI 318: 3.5.2	
IBC	3. Inspection of bolts to be installed in concrete prior to and during placement of concrete, where allowable loads have been increased or where strength design is used	ACI 318: 8.1.3, 21.2.8	1911.5 1912.1
IBC	4. Inspection of anchors installed in hardened concrete.	ACI 318: 3.8.6, 8.1.3, 21.2.8	1912.1
IBC	5. Verifying use of required design mix	ACI 318: Ch. 4, 5.2-5.4	1904.22, 1913.2, 1913.3
IBC	6. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, determine the temperature of the concrete	ASTM C172, C31; ACI 318: 5.6, 5.8	
IBC	7. Inspection of concrete and shotcrete placement for proper application techniques	ACI 318: 5.9, 5.10	1913.6, 1913.7, 1913.8
IBC	8. Inspection for maintenance of specified curing temperature and techniques	ACI 318; 5.11-5.13	1913.9
IBC	9. Inspection of prestressed concrete: a. Application of prestressing forces b. Grouting of bonded prestressing tendons in the seismic-force-resisting system	ACI 318: 18.20 ACI 318: 8.18.4	
IBC	10. Erection of precast concrete members	ACI 318: Ch.16	
IBC	11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318: 6.2	
IBC	12. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318: 6.1.1	
DGS	Review Contractors' design mixes, Certificates of Compliance and material test reports		
DGS	Compressive Strength of Cylindrical Concrete Specimens[2]	ASTM C39	
	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 Certification of Compliance required	AISC 360, Section A3.3 and applicable ASTM material standards	

REQ'D BY[1]	DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	IBC REFERENCE[2]
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. Manuf 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 appr 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	

REQ'D BY[1]	DESCRIPTION OF TEST OR INSPECTION	REFERENCED STANDARD	IBC REFERENCE[2]
	General Overview of QC testing		
DGS	Review of QC Testing and Reports		

Footnotes-

1. "DGS" are tests required by the Department of General Services and "IBC" are test required by chapter 17 of the 2009 edition of the International Building Code.
2. IBC 2009.
3. Quality Assurance for soils may be performed/provided by the Professional's Geotechnical Engineer under a separate work order issued by DGS to the Professional.

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.

1.3 TEMPORARY WATER SUPPLY

A. To maintain an adequate water supply during the period of construction, the Plumbing Contractor shall tie into the facilities' permanent water supply line. 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. The HVAC Contractor may install, operate, protect and maintain a temporary heating system through connections to existing steam or hot water lines. [Obtain approval from the Client Agency for connection to existing steam or hot water systems. If connection is not allowed, edit the forgoing sentence. If connection is allowed, but payment for steam or hot water is required, require metering by the Contractor and a cost basis for use. The Client Agency may, within the limitations of the existing facilities, provide heat at no cost. Require the Contractor to provide all temporary connections and necessary equipment to adapt the existing heating system to provide temporary heat. Regardless of whether the new permanent heating system is used for temporary heat, require in Division 23 that all equipment warranties commence upon acceptance of the building for occupancy.]

E. Temporary heating system, as hereinafter noted, shall be of sufficient capacity to heat the interior of the building to 60°F when outside temperature is 0°F. The interior temperature must be 60°F or above at all times. This service shall be continued until the entire Project is completed, except as hereinafter noted.

F. Where electricians or plumbers are required to install, operate supervise or maintain equipment used in the provisions of temporary heat, the payment of the services of such material and personnel shall be the responsibility of the Electrical and the Plumbing Contractors respectively. It will be the responsibility of the Electrical and Plumbing Contractors to coordinate with the HVAC Contractor for temporary heat.

G. The Lead Contractor shall pay for all fuel and electricity for the temporary heat in conjunction with the operation of heating equipment for enclosed buildings, or enclosed portions thereof, unless provided by the Client Agency as noted above.

H. The Lead Contractor shall remove normal soot, smudges, and other deposits from walls, ceilings and exposed surfaces which are the result of the use of any temporary heating equipment after enclosure, including the use of the permanent heating system for temporary heating purposes. Finish work shall not start until all such surfaces are properly cleaned. Soot, etc. caused by equipment malfunction shall be removed by the responsible Contractor. Each Prime Contractor shall correct/replace any of their respective work that is identified by the Department or Professional as not meeting the project specifications as a result of the failure of any Prime Contractor to maintain or provide appropriate temporary heat, cooling, dehumidification, or ventilation in accordance with the contract requirements or the manufactures requirements. Each Prime Contractor will follow the requirements of the General Conditions regarding any disputes due to another Prime Contractor's failure to provide or maintain proper temporary heating, cooling, dehumidification, or ventilation of the conditioned space. Each Prime Contractor shall correct/replace any of their respective work that does not meet Contract requirements due to use of temporary heat.

I. All permanent heating equipment used to supply temporary heat shall be completely cleaned and reconditioned by the HVAC Contractor, in the presence of the Department personnel, prior to Final Acceptance. Cleaning of permanent HVAC ducts utilized for temporary heat shall be required. The HVAC Contractor should filter the return air at grilles, and wherever necessary to prevent dust accumulation. All permanent heating equipment, such as radiator trap seats and diaphragms, valve sets and discs, strainer internals or any other equipment found to be damaged due to being used for temporary heat shall be replaced. All replacements must be inspected by the Professional and accepted by the Department personnel. The HVAC Contractor shall pay for all replacement parts and labor.

J. The cost of temporary heat shall be made a part of the lump sum bid submitted by each Contractor, as applicable. The cost of temporary heat after enclosure shall be shown on the Contract Schedule of Values, to include the number of calendar days, cost per twenty-four (24) hour day and extended price. Any adjustment to the number of days of temporary heat, used or not used, may be based on this unit price. Each Contractor shall include [75] 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. A burn permit must be obtained from the facility fire/safety Marshall for welding or burning inside the building.

B. Each Contractor shall provide necessary exhaust/ventilation/filtration to prevent accumulation of welding fumes and smoke generated by welding their operations.

C. Any Contractor using electrical power for welding on the site shall use self-contained engine generating units. If welding is conducted indoors, the fire alarm shall be deactivated and/or protected.

1.7 FIRE EXTINGUISHERS

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

1.8 INTERRUPTION OF SERVICES

A. Each Prime Contractor shall have all needed equipment and material to complete planned work at the site, prior to shutting down any system.

B. No additional compensation or time will be given to the Contractor, if work must be performed on State or National Holidays or on weekends or on overtime. See paragraph on ‘Working Hours’ under Section 010400.

C. Contractors are to follow all requirements stated in Articles 6.21 and 6.22 of the General Conditions and submit the "Utility Shutdown Checklist" form accessed through the eBuilder Forms Module for approval. Forms are located under the Project Menu along the left column of eBuilder. The "Utility Shutdown Checklist" form is list"All Workflow and Static Forms" drop-down menu.

1.9 SNOW/ICE REMOVAL

A. The Lead Contractor shall be responsible to provide snow removal and anti-skid material into to site and at the project site and indicated laydown areas (including construction trailer), unless directed otherwise.

B. All related work shall be performed to provide proper and safe access throughout the site subsequent to each related work day. Any delay and potential related costs generated by failure to meet this requirement shall be the responsibility of the Lead Contractor.

1.10 DEWATERING

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

1.11 HOISTING FACILITIES

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

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 016150

DHS – SUPPLEMENTAL PROVISIONS CONTRACTOR BEHAVIOR AND ACTIVITIES AT DEPARTMENT OF HUMAN SERVICES YOUTH DEVELOPMENT CENTERS, MENTAL HEALTH AND STATE CENTERS

PART 1 – GENERAL

1.1 STIPULATIONS

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

1.2 PERSONAL BEHAVIOR

A. Contractors are responsible for disseminating to their employees the special restrictions on personal behavior and the procedures/potential penalties for violations.

B. Identification tags or badges to be furnished by the facility must be worn at all times while on facility property.

C. No tobacco products of any kind are permitted in any facility building.

1.3 VEHICLES

A. Construction vehicles and employee's vehicles will be parked in an area designated by the Department and locked at all times. The license numbers of vehicles to be left overnight will be reported to the onsite Maintenance Manager at the facility on a daily basis by the Contractors.

B. Vehicles may not be operated or parked on any lawn areas, unless otherwise permitted.

1.4 TOOLS

A. Tools shall be kept in a secure (locked) area when not in use and inventoried to insure complete and total accountability at the end of each shift. While being used, tools shall be kept in view or on person. Broken or non-usable tools are to be disposed of away from the facility property. Any missing or lost tools are to be reported promptly to the Facility Maintenance Manager. Particular attention should be paid to tools, which may be used as weapons or instruments of escape. Special procedures will be developed with the facility's Maintenance/Engineering Department concerning cutting pliers, bolt cutters, hacksaws and welding or cutting equipment. UNDER NO CIRCUMSTANCES WILL CUTTING TORCHES OR WELDING EQUIPMENT BE LEFT INSIDE THE PERIMETER SECURITY ENCLOSURE (at facilities with enclosures) OVERNIGHT, ON WEEKENDS OR ON HOLIDAYS.

B. No ladders may be left upright and accessible to residents. If not in use, ladders must be taken down and secured. Scaffolding must be secured to guard against unauthorized use.

C. A tool lockdown area will be designated by the Using Agency thus allowing the contractors to keep their tools stored within one of the secured wings during each sequence of construction.

1.5 WORK AREAS

A. All work areas are to be kept safe and orderly at all times.

B. All doors are to be kept locked to ensure resident safety. Doors normally unlocked are excluded, unless safety becomes an issue.

C. Passenger elevators are not to be used to transport materials, unless written authorization is given specifying dates and times when it is permissible.

D. Flammable liquids are not to be stored inside occupied buildings.

E. Do not compromise Life Safety Code requirements without prior written consent of the facility’s Safety Manager, who will develop and implement alternate plans.

F. Facility supplies are not to be utilized by Contractors, unless they are specifically spelled out in the Project Specifications.

G. Contractors are to be aware of the locations of fire alarms, fire extinguishers and related equipment. The facility Fire Marshal is available to instruct the Contractors in the proper operation of fire safety equipment.

1.6 FRATERNIZATION

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

B. In accordance with its zero tolerance policy, the Department prohibits all forms of sexual abuse and sexual harassment of juvenile in its facilities. The Contractor will comply with Department policy and with the Prison Rape Elimination Act of 2003 (PREA) and its regulation at 28 C.F.R. Part 115 Subpart D, Standards for Juvenile Facilities.

At a minimum, the Contractor will provide a copy of DHS's Zero Tolerance for Sexual Abuse and Harassment pamphlet to all staff members, including staff of subcontractors who have any contact with juvenile at the facility and will provide to the Department confirmation of each staff member's receipt and understanding of the pamphlet to any new staff that may be hired for the duration of the contract. Contractor staff members/subcontractors will not be permitted to provide services until completed sign-off forms are received for those individuals who may come in contact with juveniles at the facility.

The Department may require Contractor's staff, including that of subcontractors to undergo additional Department provided training on their responsibilities under the Department's sexual abuse and sexual harassment prevention, detection and response policies and procedure. The Department will determine whether additional training is required based upon the nature of contracted services and the level of contact with juveniles at the facility.

1.7 ALCOHOL AND CONTROLLED SUBSTANCES

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

1.8 GAMBLING

A. Gambling or wagering of any type is not permitted on facility property.

1.9 WEAPONS OR IMPLEMENTS FOR ESCAPE

A. Weapons or implements of escape (other than tools applicable in Paragraph 1.4) shall not be permitted on facility property. Non-compliance with this policy may result in criminal charges.

B. Offense Defined - A person commits a 2nd degree felony if that person unlawfully introduces within a Youth Development Center, Mental Health Hospital, or State Center unlawfully provides a resident thereof with any weapon, tool, implement or other item which may be used for escape.

C. Definitions:

1. As used in this section, the word "unlawfully" means surreptitiously or contrary to law, regulation, or order of the detaining authority.
2. As used in this section, the word "weapon" means any implement readily capable of lethal use and shall include any firearm, knife, dagger, razor, other cutting or stabbing implement or club, including any item which has been modified or adapted so that it can be used as a firearm, knife, dagger, razor, other cutting or stabbing implement or club. The word "firearm" includes any unloaded firearm and the unassembled components of a firearm.

1.10 CONTRABAND

A. Contraband shall not be permitted on facility property. Non-compliance with this policy may result in criminal charges.

B. Contraband transferred by any means to confined persons is prohibited. A person commits a misdemeanor of the first degree if that person sells, gives or furnishes to any resident in a Youth Development Center, Mental Health Hospital, or State Center, or gives away or brings into any Youth Development Center, Mental Health Hospital, or State Center or any building appurtenant thereto, or on the land granted to or owned or leased by the Commonwealth for the use and benefit of the residents, or puts in a place where it may be secured by a resident or employee thereof, any kind of spirituous or fermented liquor, drug, medicine, poison, opium, morphine, or other kind of narcotics (except the ordinary hospital supply) without a written permit signed by a physician of such facility, specifying the quantity and quality of the liquor or narcotic which may be furnished to any resident or employee; the name of the resident or employee for whom it is prescribed; and the time when the same may be furnished, which permit shall be delivered to and kept by the superintendent of the facility.

C. Money transferred directly to residents is prohibited. A person commits a misdemeanor of the third degree if that person gives or furnishes money to any resident of a Youth Development Center, Mental Health Hospital, or State Center, PROVIDED NOTICE OF THIS PROHIBITION IS ADEQUATELY POSTED AT THE FACILITY.

1.11 SEARCH

A. Any person entering this facility is subject to a search of his or her person at any time. While the person may refuse, such refusal may be cause for denial of further entrance.

1.12 ORIENTATION PROGRAM

A. The contractor must attend an orientation program covering security rules and regulations if required by the facility.

B. If not required by the facility, the facility agrees to provide such an orientation program for covering security rules and regulations for the Contractors' personnel, if so requested.

1.13 EMPLOYEE CRIMINAL RECORD CHECK

A. The Prime Contractor must obtain a criminal record check for all of its employees as well as the employees of Subcontractors or suppliers who will be required to enter the building as part of this project.

B. The criminal record check must be requested from the Pennsylvania State Police by completing a 'REQUEST FOR CRIMINAL RECORD CHECK' FORM and submitting it to the Pennsylvania State Police. **An FBI check is required if the contracted person is not a PA resident.**

C. All Prime Contractors are responsible for the costs incurred with the record check including the $10.00 processing fee for all of their employees as well as the employees of Subcontractors or suppliers who will be required to enter the building as part of this project.

D. The forms must be obtained directly from the Pennsylvania State Police.

E. If the Criminal Record Check discloses a criminal record for a Contractor, Subcontractor or supplier employee, the Contractor shall not allow the employee access to the building, unless authorized by the Department.

F. Contractors must submit the request for criminal record check to the Pennsylvania State Police with a copy to the Department not less than twenty-four (24) hours prior to individual starting work on the project.

G. The Contractor shall provide each individual with a photo identification card or badge issued by the Contractor or Subcontractors. The identification card shall include the individual's name, address, telephone number, date of birth, driver's license number, and date of issuance of the card.

H. **CLARKS SUMMIT STATE HOSPITAL ONLY:** All Contractors are required a $10.00 deposit for ID badges. Upon completion, and return of badges (during normal working hours), deposit will be returned.

I. **LOYSVILLE YOUTH DEVELOPMENT CENTER, NORTH CENTRAL SECURE TREATMENT UNIT, SOUTH MOUNTAIN SECURE TREATMENT UNIT, YOUTH FORESTRY CAMP No.2 and YOUTH FORESTRY CAMP No. 3 ONLY:** Additional background checks are required at these facilities to supplement the items described above. Background clearance checks will apply for Contractors to gain entry to Danville State Hospital Green and Reed buildings. Additional information on the required clearances can be found on the Pennsylvania Department of Human Services website:

https://www.dhs.pa.gov/KeepKidsSafe/Clearances/Pages/default.aspx

1. A Child Abuse History Clearance from the Pennsylvania Department of Human Services is required for all contractors, sub-contractors, suppliers and their collective employees who will be required to enter a building as part of this project.

2. An FBI background check is required for all contractors, sub-contractors, suppliers and their collective employees who will be required to enter a building as part of this project, regardless of Pennsylvania residency.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION (Not Applicable)

END OF SECTION

SECTION 017000

COMMONWEALTH OF PENNSYLVANIA – COVID-19 PROVISIONS

PART 1 – GENERAL

1.1 STIPULATIONS

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

1.2 ZERO TOLERANCE

A. DGS Public Works has a zero tolerance for a Prime Contractor's non-compliance with the Governor's Office Guidance and this Supplemental Guidance for DGS Public Works Projects, collectively "DGS Guidance".

B. An authorized representative from each prime contractor will be required to acknowledge reading and understanding the DGS Guidance before anyone in that firm or their subcontractor, vendors or consultants can physically access the site.

C. Any issue of creditable report regarding non-compliance with the guidance shall be a basis for the suspension of work. The Prime Contractor will be required to submit a corrective action plan detailing each issue of non-conformance and a plan to rectify the issue(s). The contractor will not be allowed to resume work until the plan is submitted to DGS.

1.3 PANDEMIC SAFETY OFFICER

A. Each Prime Contractor shall provide the DGS Assistant Project Coordinator assigned to the project the name of their designated site-specific Pandemic Safety Officer (who may also be the Safety Officer).

B. The Pandemic Safety Officer shall be responsible for observing employees and using best efforts to ensure their employees and all their subcontractors and suppliers comply with this DGS Guidance. At the start of each shift, the Pandemic Safety Officer must confirm that all employees reporting to the site are healthy and not experiencing any symptoms below.

COVID-19 Typical Symptoms:

1. Fever
2. Cough
3. Sore Throat
4. Shortness of Breath
5. Early symptoms such as chills, body aches, headache, diarrhea, nausea/vomiting and runny nose.

D. If any employee exhibits any of the identified symptoms, the Pandemic Safety Officer must act in accordance with the Prime Contractor's Amended Site Safety Plan, which should include removing an observed sick employee from the project site immediately. As provided by law, the identity of the worker must be kept confidential.

E. Any employee who develops COVID-19 as confirmed by laboratory testing or diagnosis by a healthcare provider shall not return to the site until released from isolation by either the healthcare provider or a public health official.

1.4 AMENDED SITE SAFETY PLAN

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

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

1.5 NOTIFICATION OF EXPOSURE

A. Upon learning of an infection, the Pandemic Safety Officer must immediately provide written notification to the other Prime Contractors' designated Pandemic Safety Officer, the DGS Assistant Project Coordinator and the Client Agency's site representative, while maintaining patient confidentiality.

B. Each Prime Contractor must comply with all OSHA requirements relating to COVID-19. As of April 24, 2020, OSHA has determined that confirmed cases of COVID-19 shall be considered an "illness" for purposes of the OSHA 300 Log and Form 301.

C. DGS reserves the right to suspend the project if it receives credible written confirmation of a positive test for any person on the project site.

D. DGS will issue each Prime Contractor an excusable, non-compensatory extension of time covering any suspension for a positive test.

1.6 JOB SITE REQUIREMENTS

A. Contractor and DGS job trailers are restricted to only authorized personnel.

B. Each Prime Contractor shall develop cleaning and disinfecting procedures for their job trailer and equipment. The Lead Contactor shall follow their cleaning and disinfecting procedures for cleaning and decontamination of the DGS Field Office aligned to CDC guidelines. The procedures must cover all areas including trailers, gates, equipment, vehicles, etc. and shall be posted at all entry points to the site and throughout the project site.

C. Each jobsite must have laminated COVID-19 safety guidelines and handwashing instructions.

D. Provide hand wash stations at appropriate locations on the site such as building entrances, break areas, food truck areas, offices, trailers, and job site egress areas.

E. All restroom facilities/porta-potties should be cleaned, and handwashing stations must be provided with soap, hand sanitizer and paper towels.

F. All surfaces should be regularly cleaned, including surfaces, door handles, laptops, etc. All common areas and meeting areas are to be regularly cleaned and disinfected at least once a day.

G. A "social distancing" policy shall be enforced. Individuals must implement social distancing by maintaining a minimum distance of 6 feet from other individuals unless specific work requires deviation.

a. No handshaking.
b. No visitors allowed on the job site.
c. Site deliveries must be properly coordinated with the Prime Contractor's Safety Plan. Where possible, delivery personnel should remain in their vehicles.
d. Conduct all meetings via conference calls or web meeting sites if possible. Do not convene meetings of more than 10 people. Individual work crew meetings should be held outside and follow social distancing.
e. Endeavor to keep all crews a minimum of 6 feet apart at all times to eliminate the potential of cross contamination.
f. Stagger shifts, breaks, work areas and/or stacking of trades where feasible to minimize workers on site.
g. Limit tool sharing and sanitize tools if they must be shared.
h. In work conditions where required social distancing is impossible to achieve, affected employees shall be supplied PPE, including as appropriate a standard face mask and eye protection.

1.6 LIMITATIONS ON PERSONNEL

A. Enclosed projects or portions of enclosed projects may not permit more than four persons on job sites of 2,000 square feet or less.

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

1.7 CLIENT AGENCY SPECIFIC REQUIREMENTS – DEPARTMENT OF HUMAN SERVICES – OCYF FACILITIES

A. Each contractor's employee(s) will be required to have their temperature taken with an infrared thermometer at the beginning of their shift. If the contractor's employee has a fever of 100.0 or higher or exhibits signs of coughing or shortness of breath, they will not be permitted entry to DHS OCYF property.

B. Any contractor employee that is tested and found to be positive for COVID-19 shall not be permitted to return to the facility for minimum of 14 days, or 10 days and after 2 consecutive negative tests at least 24 hours apart.

C. If an employee does not have a fever but exhibits signs of coughing or shortness of breath or is in close contact with a person who is under investigation for COVID-19, that employee will be denied entry to the institution.

D. Infrared or digital thermometers will be used in conjunction with a questionnaire prior to entrance to the job site on Commonwealth property.

E. The contractor is strongly encouraged to conduct employee tracking to further identify possible spread of COVID-19.

PART 2 –PRODUCTS (Not Used)

PART 3 –EXECUTION (Not Used)

END OF SECTION

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

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

Prime Contractor Company Name:

_____

Prime Contractor's Authorized Representative:

_____

Representative's Signature:

_____

Date: _____

SECTION 019000 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.1. SUMMARY

A. The systems installed under Divisions 22, 23, 26, 27, 28 as well as pieces of equipment provided under other Divisions that connect to or interface with the systems of Division 22, 23 and 26 will be evaluated, started, and tested (commissioned) to ensure that each performs per the intent of the design and/or representations made relative to performance, efficiency, and suitability for application in this project.

B. The Department has employed an independent Commissioning Agent. The Commissioning Agent is an independent and knowledgeable third party, hired to verify that the systems work as per the design intent and to perform the commissioning responsibilities as designated in this specification. The Commissioning Agent shall inform the Client Agency of the results of commissioning and provide suggestions, as necessary, to correct deficiencies in observed performance or installation.

1.2. COMMISSIONING OBJECTIVES

A. Commissioning is intended to achieve the following specific objectives:

1. The Client Agency will ultimately inherit a building that is designed to meet the needs of the building occupants and is built and functions as designed.

2. Systems performance expectations are clearly established.

3. Corrective actions will be made in a manner that will not compromise long-term utilization or operating expense.

4. The Client Agency’s operating personnel will have the integrated system training needed to confidently operate and maintain the systems.

5. Achieve the requirements outlined in LEED New Construction version 2.2 for Fundamental Commissioning Prerequisite #1 and Enhanced Commissioning Credit #3.

B. The Commissioning Agent will be employed directly by The Client Agency to perform commissioning duties. Sections 22 0800, 23 0800, 26 0800, outline the specific commissioning responsibilities of each Prime Contractor for that division.

1. This section of the specification describes the process for commissioning and defines the responsibilities of the Prime Contractors.

2. The commissioning process shall be applied to all equipment, components, and systems as listed in this section, including specific interfaces to and from equipment and systems provided under separate contracts.

3. Building Commissioning is a joint team effort to ensure that all systems function together properly to meet the design intent, and to document system performance parameters for fine-tuning of control sequences and operations procedures. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, Client Agency training, and performance testing. This section does not supersede other requirements of the specifications. It may, though, expand on some of them.

4. Complementary to the Prime Contractor's responsibility to start-up the building systems the Commissioning Agent will provide equipment-systems installation inspection and performance verification. These verifications will be a prerequisite to final equipment and systems acceptance by the Client Agency as per design documents. It should be emphasized that the systems verification does not negate the Prime Contractor's obligations to fully start-up the building systems or relieve the Prime Contractor of any contractual obligations. The Prime Contractor's personnel shall be made available to execute all aspects of the Commissioning Process until final building acceptance by the Client Agency. Commissioning Program tasks and meetings may be repeated until the Client Agency and the Commissioning Agent are satisfied.

5. The Commissioning Agent will verify equipment-systems installation and performance after the Prime Contractor provides written notice that the building equipment and systems installations have been completed, tested, and are fully operational. Upon this notification, the Commissioning Agent will verify the installation and performance of the equipment and system(s). Subsequent installation and performance verifications will be at the Prime Contractor's expense. The Prime Contractor is responsible for all systems and equipment until final acceptance by the Client Agency. All guarantees and warranties shall not begin until final acceptance by the Client Agency.

1.3. CONSTRUCTION TEAM RESPONSIBILITIES

A. Within 15 business days of the Notice to Proceed, the HVAC, Plumbing and Electrical Prime Contractors shall submit the names of their Project Managers who will be the commissioning coordinators for this project, as well as the names, addresses, phone numbers and qualifications of Prime Contractors' representatives and factory trained manufacturers' representatives for all equipment and systems required to participate in the commissioning process as specified in this Section.

B. The Prime Contractors and suppliers shall cooperate with the Commissioning Agent in carrying out the commissioning process. In this context, each Prime Contractor shall:

1. Provide equipment and systems start-up as specified.

2. Operate equipment and systems as required for initial systems operations and for final functional performance tests as they are performed by the Commissioning Agent, including the on-site participation of approved factory trained manufacturer's representatives for equipment.

3. Attend commissioning meetings, and attend to action items arising from them, as required to allow the commissioning process to proceed on schedule.

4. Provide instruction and demonstrations for the Client Agency's designated operating staff, in conjunction with the Commissioning Agent, in order to meet all specified training requirements in this regard.

5. The Prime Contractors shall make any and all necessary corrections to systems, equipment, O&M manuals, as built drawings, and procedures as necessary to meet the design intent, contract documents, or performance requirements if errors are discovered during the commissioning process.

6. The Prime Contractors shall supply all necessary documentation, such as shop drawings, submittal data, maintenance manuals, etc. required for equipment and systems, to the Commissioning Agent for preparation of the commissioning plan, checklists, and functional performance plans.

7. The Prime Contractors shall provide the required names, addresses and qualifications of all specified manufacturer's representatives to participate in the commissioning process prior to the initial commissioning meeting.

8. Subsequent installation and performance verifications, made necessary due to required corrections after initial verification, shall be at the respective Prime Contractor's expense.

C. The Commissioning Agent has access to the following items via e-builder:

1. Construction schedule, including sub-schedules and milestones for all major mechanical and electrical equipment. (i.e. chillers, motor control center, air handlers, generators, VAV boxes, etc.)

2. Certified and approved start-up and testing reports for all subsystem equipment that comprise the system.

3. Control schematics and sequences of operation for the total system and all subsystems.

4. Records of required inspections for code compliance, and documentation of approved permits and licenses to operate components of the system.

5. Operating data including all necessary instructions to the Client Agency's operating staff in order to operate the system to specified performance standards.

6. Maintenance data including all necessary information required to maintain all equipment in continuous operation, such as the testing, balancing and adjusting report and as-built drawings.

7. Written notice that building equipment and systems have been completed, tested, and are fully operational.

8. Checklist of all submitted contract deliverables such as O&M manuals, spare parts, Client Agency training and equipment start-up reports.

1.4. COMMISSIONING TEAM MEMBERS

A. The members of the commissioning team shall consist of the following:

1. Commissioning Agent (CA)
2. Client Agency
3. The Professional
4. PADGS (The Department)
5. HVAC Prime Contractor
6. Plumbing Prime Contractor
7. Electrical Prime Contractor
8. Automatic Temperature Controls (ATC) Prime Contractor
9. Testing Adjusting Balancing (TAB) Prime Contractor

B. DEPARTMENT RESPONSIBILITIES

1. Promote cooperation between the Prime Contractors and the commissioning team.

2. Attend commissioning specific pre-construction, planning and testing meetings. Coordinate with the Commissioning Agent for inputting the timing and duration of the commissioning activities into the master scheduling process.

3. Work with the Client Agency, Prime Contractors, and Commissioning Agent to coordinate each training session with the appropriate personnel.

4. Coordinate with the Commissioning Agent for those systems included in Divisions 22, 23 and 26.

5. Coordinate directly with each Prime on the project specific responsibilities and contractual obligations with regards to commissioning.

6. Note any inconsistencies or deficiencies in system operations and enforce system compliance.

7. Oversee training for the systems specified in Divisions 22, 23, 26, 27, and 28

C. PRIME CONTRACTOR RESPONSIBILITIES

1. Review the plans and specifications with respect to the completeness in all areas relating to Commissioning. This includes ensuring that there are adequate items included in the design to ensure the ability to properly test, balance, and adjust the systems and to document the performance of each piece of equipment and each system. Any items that are required for Commissioning but not shown shall be brought to the attention of the Commissioning Agent and PADGS prior to submittal of shop drawings. Likewise, any items that are required for Commissioning but not installed shall be provided at no additional cost to the project as per the design intent.

2. Provide qualified personnel for participation in systems tests, including seasonal testing required after the initial testing.

3. Cooperate with Commissioning Agent personnel, provide access to work, and provide adequate time in the work for commissioning tasks.

4. Include the cost for commissioning requirements in the contract price.

5. Provide written documentation that the systems are complete and ready for functional testing verification.

6. Correct all Prime Contractor related deficiencies identified during any stage of the commissioning process.

7. Furnish copies of all shop drawings, manufacturers' literature, maintenance information, or other information as may be requested.

8. Coordinate the trades as per the Commissioning Agent's testing and pre-testing responsibilities.

9. Provide training with the assistance of the Commissioning Agent as outlined in Divisions 22, 23 and 26.

10. Provide to the Commissioning Agent all proprietary test equipment required by manufacturers to test their equipment.

11. Provide technical expertise to oversee, direct, and implement the correction of deficiencies found during the commissioning process. Observe the start-up and initial testing of equipment by the Prime Contractors and then all final HVAC, building automation, fire alarm, emergency power, life safety, etc. The Prime Contractor's personnel shall execute the Commissioning Program until the Department and Client Agency accept the final results. Commissioning tasks and meetings may be repeated until the Department and Commissioning Agent are satisfied.

12. Note any inconsistencies or deficiencies in system operations and enforce system compliance or recommend modifications to system design to improve system performance.

13. When equipment tests, results, and forms of documentation required by the contract documents are completed by the respective Prime Contractors, notify the Client Agency, the Department, and Commissioning Agent that the systems are fully operational. After such time, the Commissioning Agent will verify systems performance.

14. In the event that a performance verification test by the Prime Contractor fails, the cause of failure shall be determined by the Commissioning Agent and rectified as soon as possible by the Prime Contractor, and then re-tested by the Commissioning Agent.

15. Additional, specific commissioning responsibilities for each Prime Contractor are included in the respective specification sections noted: 23 0800, and 26 0800.

D. COMMISSIONING AGENT'S RESPONSIBILITIES

1. The Commissioning Agent is contracted directly with the Department and coordinates with the Department on-site.

2. Develop and submit a detailed commissioning plan that would include all system testing requirements including, pre-functional and functional testing sheets, responsibilities, O&M manual and training requirements and forms.

3. Execute the commissioning program, through organization of all meetings, tests, demonstrations, performance verification.

4. Develop pre-functional and functional test procedures for all equipment and systems. Test procedures shall be in accordance with the manufacturer's recommendations and shall fully describe the system configurations and tests for each component and system. Each test procedure shall include specific criteria, measured test results versus design requirements, prefunctional test sheets, approved submittal and Prime Contractor required testing.

5. Develop and maintain the commissioning schedule that shall be updated during each commissioning meeting.

6. Review all shop drawings, coordination drawings and submittals for completeness, accuracy and operational accessibility. All deficiencies shall be documented and submitted to the Design Engineer for review.

7. Coordinate directly with the respective Prime Contractors during the commissioning meetings to develop the commissioning requirements and schedules.

8. Witness a sampling of Prime Contractor required testing including; piping hydrostatic and duct leakage tests. The Prime Contractors shall be responsible for coordinating these tests with the Commissioning Agent.

9. Participate in factory testing (ie. Air-handling factory testing) as identified by the contract documents. The Commissioning Agent shall coordinate any factory testing with the Prime Contractors.

10. Review the record drawings and "as-built" documentation for clarity and accuracy. Any discrepancies identified during this review shall be documented and shall be returned for resubmission.

11. Review all operational and maintenance manuals for pre-approval prior to submission to the Professional. Any discrepancies identified during this review shall be documented and returned to the Department for resubmission.

12. Perform regular construction installation inspections and include any identified deficiencies in the regular commissioning meetings. These items shall be reviewed and discussed during the commissioning meetings.

13. Participate in the Testing Adjusting and Balancing process and perform random sampling of air and water testing to ensure completeness of services.

14. Conduct an independent, complete, point-to-point verification of the building's automation system once the Automatic Temperature Control Prime Contractor submits in writing that their point-to-point is complete.

15. Cooperate with the Department; provide qualified personnel.

16. Promptly notify the Department of irregularities or deficiencies of work observed during performance of services.

17. Test all systems as defined in the Commissioning Plan and the written functional test procedures.

18. Work directly with the Commissioning Team to provide resolution of deficiencies and provide recommendations to the team.

19. The Commissioning Agent is not authorized to:

    1. Release, revoke, alter, or expand requirements of the Contract Documents.

    2. Approve or accept any portion of work.

    3. Perform any duties of the Department or Prime Contractors.

1.5 SYSTEMS TO BE COMMISSIONED

A. HVAC

1. Air Handling Units
2. Make-up Air Unit
3. Energy Recovery Ventilation Units
4. Steam to Hot Water Heat Exchangers (building heating hot water)
5. Steam Pressure Reducing Stations
6. Heat Pumps
7. Hot Water Systems

8. Exhaust Fans
9. Automatic Temperature Control Systems

B. Electrical

1. Normal Power Systems
2. Lighting Control Systems
3. Fire Protection Systems (Witness Only)

C. Plumbing

1. Domestic Hot Water Systems

1.6 PRE-FUNCTIONAL TEST SHEETS

A. The Commissioning Agent develops the pre-functional test sheets for each system and component to be commissioned. The pre-functional test sheets are checked out by the Prime Contractors and reviewed for completeness by the Commissioning Agent. Once pre-functional test sheets are signed-off by the Commissioning Agent, functional performance testing may proceed without unnecessary delays.

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

1.7 FUNCTIONAL PERFORMANCE VERIFICATION

A. Definition: Functional Performance Verification is the dynamic testing of systems (rather than just individual components) under full, part and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm. The systems are run through all the control sequences of operation and components are verified to operating per the contract documents.

B. Functional performance verification shall include testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verifying system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up,

cool-down, part and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, and equipment failures shall also be tested. The Commissioning Agent develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing and documents the testing. Each Prime Contractor is required is supply personnel to assist during the functional performance testing where applicable.

C. No system, equipment or component thereof shall be tested until the Prime Contractor has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the Commissioning Agent after the pre-functional testing requirements are complete and signed-off by the Prime Contractor and the Commissioning Agent. The air balancing and water balancing must be complete and the controls must be debugged prior to performance verification.

1.8 DEFERRED TESTING

A. The Prime Contractors shall be available to assist in seasonal testing, tests delayed until weather or other conditions, building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance per the contract documents. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and "As built" documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

B. TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. The Commissioning Agent shall list any outstanding items from the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the test form or on an attached sheet. The test form and any outstanding deficiencies shall be provided to The Client Agency within two days of test completion. The Commissioning Agent shall review startup testing procedures and reports and shall submit either a non-compliance report or an approval form to the Prime Contractor. The Commissioning Agent shall work with the Prime Contractors as necessary, to correct and retest all deficiencies or uncompleted items. The Prime Contractors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Agent as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the Commissioning Agent

shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and a deficiency is identified, the Commissioning Agent shall discuss the issue with the Prime Contractor and the commissioning team.

1. When there is no dispute of the deficiency and the Prime Contractor accepts responsibility for correcting it, the Commissioning Agent shall document the deficiency response, and intentions. Corrections of minor deficiencies identified may be made by the Prime Contractor during the functional performance testing, at the discretion of the Commissioning Agent. Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.

2. When the identified deficiency is corrected, the Prime Contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, the Commissioning Agent shall document the deficiency, the Prime Contractor's response, and provide a copy to the Department. Every attempt shall be made to resolve the dispute. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the Design Engineer. Final acceptance authority shall be the Client Agency.

4. During the functional performance testing of multiple units of similar equipment, the Commissioning Agent shall test all of the equipment and components that are to be commissioned. If, under such a testing procedure, three or more identical pieces of equipment (size alone does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the Commissioning Agent. In such case, the Prime Contractor shall provide the Commissioning Agent with the following:

a. Within one week of notification from the Commissioning Agent, Prime Contractor, or manufacturer's representative shall examine all other

identical units making a record of the findings. The findings shall be provided to the Commissioning Agent within two weeks of the original notice.

b. Within two weeks of the original notification, the Prime Contractor shall provide the Commissioning Agent a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall meet the specification requirements of the original installation.

c. When approved, two examples of the proposed solution shall be installed by the Prime Contractor and the Commissioning Agent shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the Commissioning Agent shall recommend the acceptance or disapproval of the proposed solution to The Client Agency.

d. Upon acceptance of the proposed solution by The Client Agency, the Prime Contractor shall replace or repair all identical items, at the expense of the Prime Contractor and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.

e. Where 15% or more of a group of devices or components have failed, it shall be deemed that the entire group failed and will require retesting once the corrections have been made. The Prime Contractor shall submit a letter to the Commissioning Agent that the corrections have been made and system can be retested.

5. Cost of Retesting:

a. The cost for the Commissioning Agent and/or Client Agency personnel to conduct the retesting of functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, was found to be incomplete or faulty, shall be the responsibility of the Prime Contractor.

b. For a deficiency identified during functional testing, not related to any prefunctional checklist or start-up fault, the Commissioning Agent and Client Agency shall direct the retesting of the equipment once all

deficiencies have been rectified. However, all costs for any subsequent retesting shall be the responsibility of the Prime Contractor.

c. Items left incomplete, which later cause deficiencies or delays during functional testing, may result in backcharges to the responsible party.

1.9 TRAINING REQUIREMENTS

A. The Prime Contractor is responsible for the training requirements. The Commissioning Agent shall be responsible for overseeing and approving the content of training the Client Agency's personnel for the equipment being commissioned. The Commissioning Agent shall provide supplemental training if required by the Client Agency. Client Agency's personnel training and orientation on equipment and systems provided by the Prime Contractor and shall meet minimum requirements as listed in Divisions 22, 23, 26, 27, & 28.

1.10 SCHEDULING REQUIREMENTS

A. The Prime Contractor shall maintain Testing and Start-ups schedules and advise the Commissioning Agent (in writing) within a minimum of 3 business days prior to commencement of testing or start-ups.

B. The Prime Contractor shall notify the Commissioning Agent within a minimum of one week prior to the commencement of the Testing Adjusting and Balancing work for both the air and the hydronic systems. Follow requirements set forth in section 23 0800.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

Not Used

END OF SECTION 019000

SECTION 024119 - SELECTIVE DEMOLITION

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. Provide all removal, proper and legal disposal work as required to complete selective demolition work and prepare existing areas for new work required including, but not limited to, the following:

1. Demolition, removal and legal disposal off-site of selected portions of the building, construction assemblies, and other incidental work, whether shown or not shown, but required to complete the installation of scheduled work, coordinated with other trades and construction components being replaced by new construction.
2. Disconnecting, capping or sealing, abandoning or removing utilities as indicated and/or required.
3. Patching, repairing and replacing areas damaged or altered by demolition work, with new materials and construction similar in kind unless otherwise indicated.
4. Demolition and removal of selected site elements.
5. Salvage of existing items to be reused, relocated or recycled.

B. Related Requirements:

1. Division 011000 "Summary of Work" for restrictions on the use of the premises, Client Agency-occupancy requirements, and phasing requirements.
2. Division 017329 “Cutting and Patching”.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Client Agency ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS CLIENT AGENCYSHIP

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

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to 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.

C. Client Agency reserves first right of refusal for removal and salvage items. Items indicated for removal and salvage remain the Client Agency's property. Remove, clean, and pack items to protect against damage and deliver to Client Agency's designated storage area with labels to identify contents of containers. Demolished materials shall become the Contractor's property and removed from the site with further disposition at the Contractor's option.

1.5 PREINSTALLATION MEETINGS

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

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

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, dust control and for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Client Agency's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.

5. Coordination of Client Agency's continuing occupancy of portions of existing building and of Client Agency's partial occupancy of completed Work.
6. Locations of proposed dust- and noise-control temporary partitions and means of egress.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to Client Agency prior to start of demolition.

D. Pre-demolition Photographs or Video: Submit before Work begins.

E. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

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

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 QUALITY ASSURANCE

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

1.9 FIELD CONDITIONS

A. Client Agency will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Client Agency's operations will not be disrupted.

1. Coordinate with the Client Agency’s continuing occupation and use of portions of the building to maintain safe emergency access to and from the facilities at all times.
2. Provide minimum of **(3)** working days advance notice to Client Agency of demolition activities that will impact Client Agency’s normal operations.

B. Conditions existing at time of inspection for bidding purpose will be maintained by Client Agency as far as practical.

1. Before selective demolition, Client Agency will remove the following items:

a. Loose furnishings and non-built-in items.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Partial Demolition and Removal: Items indicated to be removed, and not intended to be salvaged or retained by the Client Agency, but of salvageable value to Contractor, may be

removed from the project as work progresses. Transport salvaged items from the project as they are removed.

1. Storage or sale of removed items on site will not be permitted.

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

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

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:

1. Roofing.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Client Agency. Client Agency does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. Inventory and record the condition of items to be removed and re-installed and items to be removed and salvaged.

E. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect and Client Agency's Representative in accurate detail. Pending receipt of directive from Architect and/or Client Agency's Representative, rearrange demolition schedule as necessary to continue overall job progress without delay.

F. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

G. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs, preconstruction videotapes and/or templates.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs and/or video of conditions that might be misconstrued as damage caused by salvage operations.
3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Use utility and material locator equipment to locate utilities, structural elements etc. concealed within the building's construction.

B. Existing building fire protection system shall not be diminished. Removal of existing devices shall not occur until the new equipment is in place and ready for the switchover.

C. Existing Services/Systems to Remain: Locate and maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

D. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Client Agency's Facility Manager will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.

3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building. Comply with Department of Health regulations for notifying residents/ Client Agency of shutdown of service is necessary during change-over.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

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

5. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

    a. Where entire wall is to be removed, existing services/systems may be removed with removal of the wall.
    b. Contractor’s scope of work includes, and the Contractor is required and expected to, patch any hole(s) resulting in the removal and/or capping of plumbing fixture(s) and/or piping in a wall, ceiling or floor to remain to match existing conditions, unless otherwise noted.

E. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
3. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas. Provide insulated temporary weather protection at heated spaces that are required to remain heated.
4. Where temporary covered passageways are required or indicated, covers shall be constructed to sustain a minimum point loading of 500 lbs.
5. Use utility and material locator equipment prior to cutting into existing construction to locate concealed utilities. By-pass or shut-off utilities anticipated to be near the demolition area.
6. Construct temporary, insulated, solid, dustproof, partitions where required to separate areas where extensive dirt, dust, thermal and noisy operations are performed. Equip partitions with dustproof doors and security locks where passage is required. Use sound insulation to protect against noise and thermal insulation to protect against changes in temperature.
7. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
8. Cover and protect furniture, furnishings, and equipment that have not been removed.
9. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
10. Maintain dust-proof partitions and closures as required preventing spread of dust or fumes to occupied portions of the building.

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

D. Damages: Notify the Architect and Client Agency of any damages. Promptly repair damages caused to adjacent facilities by demolition work at no cost to Client Agency.

E. Traffic: Conduct demolition operations and debris removal in a manner to ensure minimum interference with pedestrian and vehicular access and exit routes as well as other adjacent occupied or used facilities.

1. Do not close, block or otherwise obstruct streets, parking areas, walks or other occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

F. Explosives: Use of explosives will not be permitted.

G. Pollution Controls: Use temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in the air to lowest practical level. Maintain a minimum of 0.1 inches of water, negative pressure from point of enclosure. The area shall be exhausted from a location as

remote as possible from unaltered areas. The point of exhaust shall be a minimum of 25 feet from any air intake or building opening in compliance with regulations as established by the environmental protection agency and applicable governmental and local requirements.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."
10. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.
11. Where repairs to existing surfaces are required, patch to produce surfaces with the integrity and visual appearance of the original installation when it was new and suitable for new scheduled finish materials.
12. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.
13. Patch and repair all surfaces in the newly created space(s) where demolition work extends from one finished area into another. Provide a flush and even surface of uniform stability, color and appearance.

    a. Closely match integrity, texture and finish of existing adjacent surfaces as when they were newly installed.
    b. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

c. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and first finish coat.
d. Remove existing applied finishes over the entire unbroken surface area and replace with new materials, if necessary, to achieve uniform color and appearance.
e. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Client Agency.
4. Transport items to Client Agency's storage area designated by Client Agency.
5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate structural deck.
3. Remove HVAC equipment without release of refrigerants.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Client Agency's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Client Agency's property and legally dispose of them.

3.7 REPAIRS

A. Use repair materials identical to existing materials to the fullest extent possible.

B. Where identical materials are unavailable or cannot be used for exposed surfaces, code or hazard issues, use code compliant materials that visually match and are compatible with existing adjacent surfaces, that are free of damage, defects, deterioration, as originally installed when new, to the fullest extent possible pending approval by the Architect.

C. Use materials whose installed performance equals or surpasses that of the existing materials as originally installed and complies with applicable codes.

3.8 CLEANING

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

B. Change filters on air handling equipment at completion of selective demolition operations.

END OF SECTION 024119

SECTION 033000 – CAST IN PLACE CONCRETE

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.

B. Cement Concrete Pavement shall be performed in accordance with Sections 502 and 503 of the New Jersey of Transportation Standard Specifications, latest edition.

1.2 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:

1. Reinforced Colored Stamped Concrete

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for general building applications of concrete.

C. Temporary repair and patching of sidewalks in areas excavated under this Contract is also included herein. Replacement of sidewalks which have been recently built and damaged due to excavation shall be included.

D. All colored concrete to be colored (both integral and surface applied) with sealer and shark skin additive. Color to selected/approved by the Client Agency prior to purchase and installation.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Qualification Data: For manufacturer.

D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

1. Aggregates.

E. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

1. Cementitious materials.
2. Steel reinforcement and reinforcement accessories.
3. Admixtures.
4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.
8. Color additives and, sealer

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

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

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I/II,.

B. Normal-Weight Aggregates: Aggregate shall be provided as per Section 901.12 of the New Jersey Department of Transportation Specifications.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide 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.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Water: Potable.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): As per Specification Section 914 and as per plans.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: As per Specification Section 914
3. Slump Limit: As per Specification Section 914.

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:

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

2.8 COLORED CONCRETE

A. Reinforced Colored, Stamped Concrete, 6" Thick
   1. All scores and expansions shall be field verified by Landscape Architect prior to installation. Contractor to submit score/expansion plan for approval prior to forming.
   2. **All concrete to be both integral and surface applied**.
   3. HNC shark Grip or approved equal.
   4. Integral color to be selected by Client Agency prior to ordering materials.
   5. Color for the stamped concrete will be with the dry-shake color hardener product. Sealer application shall be a siloxane modified product, Deco Guard by SDI (Sealant Depot Industries). Pattern / texture pattern to be "chiseled stone" fieldstone.
   6. Expansion and decorative cuts to be accomplished by saw cut method and/or v groove blade.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 2 Section "Earthwork."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

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

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings 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 pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows to match jointing of existing adjacent concrete pavement:

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

3.6 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. 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.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

I. Screed pavement surfaces with a straightedge and strike off.

J. 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.

K. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.

L. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. 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 deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 CONCRETE PROTECTION AND CURING

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

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

3.9 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot- long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

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 1 composite sample for each 100 cu. yd. or fraction thereof of each concrete mix 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 mix. 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 mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F 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 1 specimen at 7 days and 2 specimens at 28 days.

    a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, 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 Engineer 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 Engineer.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 033000

SECTION 054000 - COLD-FORMED METAL FRAMING

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. Exterior non-load-bearing wall framing.
2. Interior non-load-bearing wall framing exceeding height limitations of standard, nonstructural metal framing.
3. Soffit framing.

B. Related Requirements:

1. Division 055000 "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
2. Division 092900 "Gypsum Board Assemblies" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

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. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Certificates: For each type of code-compliance certification for studs and tracks.

D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

E. Evaluation Reports: For nonstandard cold-formed steel framing, post-installed anchors, and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association, or the Steel Stud Manufacturers Association.

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

E. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following, or approved equal:

1. Dale/Incor Industries
2. Dietrich Metal Framing, In.c
3. Marino/Ware; Div. of Ware Industries, Inc.
4. Unimast, Inc.
5. United States Steel

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:

    a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.
    b. Interior Non-Load-Bearing Framing: Horizontal deflection of 1/360 of the wall height under a horizontal load of 5 lbf/sq. ft.
    c. Ceiling Joist Framing: Vertical deflection of 1/360 of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.
4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

    a. Upward and downward movement of 1/2 inch.

C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

2.3 COLD-FORMED STEEL FRAMING MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:

1. Grade: As required by structural performance.
2. Coating: G90 or equivalent for metal framing at exterior applications.

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (18 ga.).
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs.
2. Flange Width: Manufacturer's standard width.

C. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure.

2.5 INTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1-5/8 inches.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges.

2.6 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.
2. Flange Width: 1-5/8 inches, minimum.

2.7 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Stud kickers and knee braces.

2.8 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

D. Welding Electrodes: Comply with AWS standards.

2.9 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:

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

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Install insulation, specified in Section 072100 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

3.3 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless fastening at top is not allowed for deflection. Space studs as follows:

1. Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.4 INTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

B. Fasten both flanges of studs to top and bottom track unless fastening at top is not allowed for deflection. Space studs as follows:

1. Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

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3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 ERECTION TOLERANCES

A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

3.6 REPAIRS AND PROTECTION

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

END OF SECTION 054000

SECTION 075323 - EPDM SINGLE-PLY MEMBRANE ROOFING

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 DESCRIPTION OF WORK

A. Provide all labor, materials, accessories, equipment, incidentals and supervision necessary to complete roofing work and repair work as shown and or specified including, but not limited to, the following:

1. Removal of existing roofing system insulation, flashings, nailers, blocking, etc. down to existing solid roof deck substrate.
2. Fully Adhered EPDM roofing system.
3. Roofing insulation.
4. Treated wood blocking and sheathing.
5. Retrofit and/or new roof drains.
6. Roof Walkway Pads.

B. Contractor will provide lifts, cranes, trucks, etc. to contain and remove materials. Accumulation of debris will not be allowed, and will be removed from the site on a daily basis and properly as well as legally disposed of off site. Contractor will police area to keep same clean of debris at all times.

C. Work to be completed in strict compliance with latest edition of OSHA Code, State and Local requirements.

D. Contractor will provide protection to persons, buildings, adjacent property, etc., and will supply all necessary materials including barricades as required, posting signs warning that men are working above, etc. to provide this protection. Damaged areas will be repaired and/or replaced to the Architect’s satisfaction at no cost to the Client Agency.

1.3 DEFINITIONS

A. Roofing Terminology: See ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to

defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.

C. Fire, Wind and Hail Resistance: Provide membrane roofing system with, base flashings, component materials and fastening / adhering methods that have been evaluated and tested by an accredited, independent testing laboratory and meets or exceeds requirements of FM for the following:

1. Fire/Windstorm Classification: Class FM 1A-90 per ASTM E 108, Class A Fire Performance Rating.
2. Hail Resistance Rating: SH.

D. Wind Load: Roof system installation shall also be in compliance with RMA RP-1 and ASTM D 4637. The roof system and installation shall meet or exceed requirements for basic wind speed and uplift resistance requirements complying with IBC International Building Code 2006, New Jersey Edition, Section 1609 Wind Loads for peak gust wind speed.

E. Weathering: Roof system manufacturer shall demonstrate that roof system installation will be in compliance with ASTM E838, G23, G26 or G53 based on 2,000 hours of exposure to accelerated weathering tests.

F. Impact Resistance: Roof covering shall resist impact damage in conformance with ASTM D3746 or D4272, or CGSB37-52 M or FM 4470.

1. Provide roof covering materials bearing testing laboratory approval marking on bundle, package or container, indicating that material has been subjected to examination and follow-up inspection service.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer's technical product data, installation details, for each type of roofing product specified. Submit manufacturer's written installation instructions and recommendations indicating special precautions required for installing the roofing system. Submit maintenance manuals with data for the entire roofing system.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, locations of roof accessories, plumbing, HVAC, electrical, special conditions and attachments to other work.

1. Iinsulation, including slopes, cants and crickets around obstructions to drain positive drainage source. Slopes indicated in the Architect's drawings reflect the actual slopes that are to result at completion of roofing installation. Fabricate so that slopes indicated are the actual slopes at completion of roofing installation.
2. Crickets, saddles, cants, and tapered edge strips, including slopes.
3. Insulation fastening patterns for corner, perimeter, and field of roof locations.
4. Base flashing and built-up terminations meeting manufacturer's written requirements, NRCA and FMG guidelines.

5. Do not submit standard details unless detail matches conditions required for this Project.
6. Submit evidence of roofing manufacturer's approval for project conditions. Modify details indicated on drawings to comply with manufacturer's requirements and specified performance and warranty requirements.

C. Specimen Warranty: Provide and unexecuted copy of the warranty specified for this Project, identifying the terms and conditions required of the Manufacturer and the Client Agency.

D. Manufacturer's Certificate: Certify that roof system furnished is approved by Factory Mutual, Underwriters Laboratories, Warnock Hersey or approved third party testing facility in accordance with ASTM E108, Class A for external fire and meets local or nationally recognized building codes.

E. Manufacturer's Certificate: Certify that the roof system is adhered properly to meet or exceed the requirements of FM 1A-90.

F. Manufacturer's Documentation: Provide copies of FM certification that the specific roof system assembly proposed has been tested and approved by Factory Mutual Approval Standard 4470.

G. Manufacturer's Certificate: Certify that materials are manufactured in the United States and conform to requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roof system specified herein.

H. Manufacturer's Certificate: Submit a certified copy of the roofing manufacturer's ISO 9001 compliance certificate.

I. Test Reports: Submit test reports, prepared by an independent testing agency, for all elastomeric sheet roofing, indicating compliance with ASTM D5147.

J. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article and complies with recognized building codes having jurisdiction at the Project site.

1. Certify that materials are chemically and physically compatible with each other and are suitable for inclusion within the total roofing system specified herein.
2. Manufacturer certifies that it approves the fasteners to be used based on pull-out tests performed by the roofing system manufacturer on the type of decks included on this project.
3. Certify that shop drawings have been reviewed and comply with manufacturer's requirements and are approved by the manufacturer and prior to submission to Architect.
4. Certify that the manufacturer will issue specified warranty for roofing installation complying with approved shop drawings.

K. Written certification from the roofing system manufacturer certifying the applicator is currently authorized for the installation of the specified roof system.

L. Installer Documentation: Include a list of five (5) projects of similar type and extent, located within a one hundred mile radius from the location of the project. In addition, the three projects must be at least five (5) years old and be available for inspection by the Architect, Client Agency or Client Agency's Representative.

M. Work on the roof(s) shall not begin until submittals have been reviewed, approved and returned to the Contractor by the Architect.

N. Pre-Installation Roofing Conference: Submit (3) copies of Pre-installation roofing conference records.

O. Submit description of manufacturer's final field inspection program. Include description of training and experience of Manufacturer's Technical Representatives. Submit written reports of all inspections and field testing performed and forward copies to the Architect on the same day.

P. Submit "As-Built" Drawings to the Roofing System manufacturer prior to final inspection by the Roofing System Manufacturer's Technical Representative to ascertain that the warranty required for this project. Written approval of the "As-Built" drawings by the Roofing System Manufacturer and issuance of the warranty from the Roofing System Manufacturer is a requirement of project close-out.

Q. Inspection Reports: Copy of the roofing system manufacturer's inspection report of the completed roofing installation.

R. Qualification data for firms and individuals identified in Quality Assurance Article.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer is UL listed, has FM Approval for membrane roofing system identical to that specified for this Project. The Manufacturer shall have not less ten (10) years of documented experience manufacturing roofing systems specified, is an Associate Member in good standing with the National Roofing Contractors' Association (NRCA). And having ISO 9001 certification. The term "Manufacturer" shall mean the actual producer of the primary roofing membrane and provider of the roofing system warranty.

1. Manufacturer's Technical Representatives: Manufacturer will be one who maintains an in-house technical department with fully qualified Technical Representatives, other than the Installer, and who are available for technical assistance, including field assistance at the project site. This Technical Representative will be required to make all necessary field inspections, and to visit the project on a minimum of twice weekly during installation and not less than one final inspection upon completion of the installation to ascertain that the roofing system is being installed in strict compliance with the manufacturer's written specifications and approved shop drawings. Technical Representative will submit written reports of all inspections and field tests performed the same day the inspection is made and shall:

    a. Keep the Architect informed as to the progress and quality of work as observed via regular written progress reports and digital photographs.
    b. Provide job site inspections not less than twice weekly.
    c. Report to the Architect in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
    d. Confirm after completion that manufacturer has observed no applications procedures in conflict with the specifications other than those that may have been previously reported and corrected.

e. The Roofing Contractor will be responsible for all costs relating to these services by the Manufacturer's Technical Representative.

B. Installer Qualifications: Company specializing in roofing installation with not less than 5 years experience and authorized by roofing system manufacturer as qualified to install manufacturer's roofing materials. Installer shall have not less than five (5) roofing projects of size and complexity required for this project.

1. Installer's Field Supervision: Maintain a full-time Supervisor/Foreman on job site during all phases of roofing work while roofing work is in progress and who is experienced in installation of the roofing system type and scope required for this project. Maintain proper supervision of workmen.
2. Maintain a copy of the Contract Documents in the possession of the Supervisor/Foreman and on the roof at all times.
3. FM Global is launching a certified roofing installer program. The Project is FM Global insured, and a certified roofing installer is required.
4. Deviations from the specifications and approved shop drawings will not be allowed without prior written approval from the Roofing Membrane Manufacturer and the Architect.
5. Installer is required to be certified and licensed by the authorities having jurisdiction for the proper and legal removal, handling, and disposal of asbestos containing materials (ACM). The Contractor shall follow all Federal, State and local ordinances, regulations and rules pertaining to asbestos, including its storage, transportation, and disposal.

C. To insure that the Manufacturer does not issue warranty coverage for work poorly installed by the Contractor, it is a condition of this Contract that there be no direct or indirect relationship between the Manufacturer and the Contractor, either legally, financially, through common Client Agencyship of stock, or through family relationships between the Client Agencys of the Manufacturer and the Contractor.

D. Source Limitations: Obtain all components of roof system from a single manufacturer. Secondary products that are required shall be recommended and approved in writing by the roofing system Manufacturer.

1. Upon request of the Architect, submit Manufacturer's written approval of secondary components in list form, signed by an authorized agent of the Manufacturer.

E. Source Quality Control: Manufacturer shall have in place a documented, standardized quality control program such as ISO-9001.

F. Comply with recommendations and standards of NRCA "Roofing and Waterproofing Manual", current edition.

G. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.

H. Fire-Resistance Ratings: Where indicated, provide fire-resistance-rated roof assemblies identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

I. Thermal-Scan Report: The Roofing Installer may be required to provide an initial and follow-up Thermal-Scan Report if moisture entry conditions become evident prior to substantial completion of the project. The Thermal Scans and Reports shall be performed, prepared, and submitted, at no additional cost, to the Client Agency, upon request of the Architect, with copies to the Architect and shall be done after all new roofing has been completed and the roof has been subjected to at least one rainfall of one-inch minimum of water. All roofing areas indicating positive (wet) areas shall be completely replaced by the Roofing Installer and include new roofing and insulation at no additional cost to the Client Agency. Final Payment shall not be made to the Contractor until a satisfactory Thermal-Scan Report has been submitted indicating a completely dry roof.

1.7 PRE-INSTALLATION ROOFING CONFERENCE: Conduct conference at Project site.

A. Pre-Installation Roofing Conference: Convene a pre-roofing conference approximately two (2) weeks before scheduled commencement of roofing system installation and associated work.

B. Require attendance of installer, Architect, Client Agency, roofing system manufacturer's representative, and other representatives directly concerned with performance of the Work, including (where applicable) Client Agency's insurers, testing agencies and governing authorities. Objectives of conference include:

1. Review foreseeable methods and procedures related to roofing work, including set up and mobilization areas for stored material and work area and manufacturer's written instructions.
2. Tour representative areas of roofing substrates (decks), inspect and discuss condition of substrate, roof drains, curbs, penetrations and other preparatory work performed by others. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
3. Review structural loading limitations of deck and inspect deck for loss of flatness and for required attachment during and after roofing work.
4. Review roofing system requirements (drawings, specifications and other contract documents).
5. Review required submittals both completed and yet to be completed.
6. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
7. Review required inspection, testing, certifying and material usage accounting procedures.
8. Review governing regulations and requirements for insurance and certificates if applicable.
9. Review temporary protection requirements for roofing system during and after installation.
10. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions, including possibility of temporary roofing (if not mandatory requirement).
11. Record discussion of conference including, decisions and agreements, (or disagreements) reached and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.
12. Review notification procedures for weather or non-working days.

C. Roofing Installer shall record discussions and agreements and promptly distribute them to the participants for record. Installer shall provide at least 3 business days advance notice to participants convening pre-roofing conference.

D. The intent of the conference is to resolve issues affecting the installation and performance of roofing work. Do not proceed with roofing work until such issues are resolved to the satisfaction of the Architect of Record. This shall not be construed as interference with the progress of Work on the part of the Architect of Record.

1.8 JOB CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements. Do not work in rain, snow or in the presence of water. Do not apply roofing insulation or membrane to damp deck surface. Do not expose materials vulnerable to water or solar damage in quantities greater than can be weatherproofed during the same day or prior to unacceptable forecasted weather.

B. Proceed with roofing work only when activities inside the facility are not scheduled and people are not present inside the building after school hours when there no scheduled classes or extra curricular activities, Saturdays, Sundays, scheduled holidays and summer break.

C. Advise Client Agency whenever work is expected to be hazardous to others and/or to operations of the facility and coordinate scheduling of this work with the Client Agency to assure maximum safety.

D. Fully complete all roofing field assembly work each day. Phased construction will not be accepted.

E. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition and in compliance with roofing manufacturer’s written requirements. Roof slopes shall not exceed 18 inches per foot and shall not be less than 1/4” per foot.

F. Manufacturer’s adhesives shall not be applied when surface and/or ambient temperatures are below manufacturer’s requirements. Catalyst may be added if approved by the Roofing System Manufacturer.

G. If this roofing system is installed during windy conditions or on projects that are not encapsulated, precautionary measures must be taken to utilize temporary ballast during installation.

H. Roof access shall be from the exterior of the building only. The Contractor is responsible for protecting against pedestrians accessing ladders or other means of accessing the roof at all times.

I. Move air-conditioning units and other equipment as required to install roofing materials complete and in accordance with plans and specifications. When units and equipment are to be moved, they shall be carefully disconnected and removed to a protected area so as not to damage any part or component thereof. Reconnect units in such a way that they are restored to

a prior work operating condition. Take appropriate measures to prevent dust, vapors, gases or odors from entering the building during roof removal, replacement or repair.

J. All disconnection and re-connection shall be performed by a mechanical and/or electrical company subcontractor licensed to perform such work.

1.9 DELIVERY, STORAGE AND PROTECTION

A. Deliver Materials to the Job Site in original unopened containers, clearly labeled with manufacturer's name, brand name, product identification, appropriate warnings, storage conditions and other identifying information visible along with written installation instructions.

B. Curable materials (i.e., uncured flashing, adhesives, sealants, cleaners, primers, seam tapes and cements, Pourable Sealer and Pressure-Sensitive Flashing, uncured flashing etc.) shall be stored be stored in accordance with manufacturer’s written requirements and between 60° F and 90° F. Prolonged exposures to temperatures greater than 90° F will reduce the shelf life of those materials. When liquid adhesives and sealants are exposed to lower temperatures, restore to a minimum of 60° F before use. Do not store adhesive containers with opened lids due to the loss of solvent that will occur from flash off.

C. Store membrane in its original wrapping or covered for protection from moisture. Store in a dry, well-ventilated, weather-tight place.

D. Store Insulation and underlayment so it is kept dry and is protected from the elements. Store insulation on a skid and completely cover with a breathable material such as tarp or canvas. If the insulation is lightweight, it should be weighted to prevent possible wind damage.

E. Protect insulation from the weather, moisture and sun while stored off the ground and on the roof deck by covering with breathable materials such as canvas and/or tarpaulin securely tied in place or adequately weighted down to prevent damage. Replace insulation damaged by exposure to water, moisture and sunlight.

F. All defective or damaged material shall be replaced with new material.

G. Fire extinguishers shall be made available within easy access on the roof during installation, and when flammable materials and cleaning agents shall be handled in such a manner to minimize the risk of fire.

H. During installation of the roofing system, care shall be exercised to avoid overstressing roof decks and the supporting structure. All superimposed loads on the roof structure shall be well distributed.

1.10 WARRANTY

A. Prior to final acceptance, a final inspection will take place with representatives of the Client Agency, Architect, Contractor, Roofing Installer and Roofing Membrane Manufacturer’s Technical Representative. All inspection reports shall be submitted to the Architect for review prior to final acceptance of the roof system.

B. The Roofing Membrane Manufacturer shall furnish the Client Agency with a Manufacturer's Twenty (20) Year NDL (No Dollar Limit Warranty) Total Roofing System Warranty from date of final acceptance including all labor and material costs to repair defects, leaks, etc. occurring in roofing system including, but not limited to, all components of membrane roofing system such as membrane roofing, base sheets, base flashing, adhesives, roof insulation, fasteners, cover boards, substrate boards, blocking, metal flashings, expansion joints, fascia, copings, and all other roof edge metals, walkway products, drains, and other components of the membrane roofing system, above the deck line.

C. Provide specified warranty for the Project, executed by the authorized agent of the Manufacturer.

PART 2 - PRODUCTS

2.1 GENERAL

A. Basis of Design: Materials, manufacturer's product designations, and/or manufacturer's names specified herein shall be regarded as the minimum standard of quality required for work of this Section. Comply with all manufacturer and contractor/fabricator quality and performance criteria specified in Part 1.

B. Compatibility: Provide products and components recommended and approved by the roofing system manufacturer to be fully compatible with indicated substrates, and roofing system or provide separation materials as required to eliminate contact between incompatible materials and to comply with written performance and warranty requirements of roofing system manufacturer and requirements of this Project.

2.2 AVAILABLE MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, Manufacturers of products that may be incorporated in the work include, but are not limited to, the following:

1. Firestone Rubber Gard EDPM Fully Adhered Roofing System.
2. Carlisle Syntec Systems; Carlisle Corp., Sure-Seal Fully Adhered Roofing System.

2.3 SYSTEM DESCRIPTION

A. Performance: EPDM Roofing Membrane shall conform to the minimum physical properties of ASTM D 4637, Type I, non-reinforced White EPDM, and as follows:

1. Physical properties of the roofing membrane:

Property	Test Method	Specification
Tolerance on Normal Thickness, %	ASTM D412	+/-10

Weights, 1bm/ft. (kg/m) .060		0.35 (1.7)
Tensile Strength, min. psi (Mpa)	ASTM D412	1650 (11.3)
Elongation, Ultimate, min, %	ASTM D412	480
Tear Strength, min, lbf (N)	ASTM D624	200(35.0)
Factory Seam Strength	Modified ASTMD 816	Membrane Rupture
Resistance to Heat Aging* Properties after 4 weeks @ 240 degrees F (116 degrees C)	ASTM D573	
Tensile Strength	ASTM D 412	1500(10.3) 890)
Elongation, Ultimate, min, %	ASTM D 412	225
Tear Strength	ASTM D 624	215(37.6)
Lineal Dimensional Change, max, %	ASTM D1204	-0.4
Ozone Resistance* Condition after exposure to 100 pphm Ozone in air for 168 hours @ 104 degrees F (40 degrees C)	ASTM D1149	No Cracks
Resistance to Water Absorption After 7 days immersion @ 158 degrees F (70 degrees C)	ASTM D471	3.6**
Brittleness Temp., max, deg. F	ASTD D 746	-67(-55)
Resistant to Water Absorption After 7 days immersion @ 158 degrees F (70 degrees C)	ASTM D 471	2.0
Water Vapor Permeance max, perms	ASTM E 96 (Proc. B or BW)	0.05
Resistance to Outdoor (Ultraviolet) Weathering Xenon-Arc. 7560 kJ/m total radiant exposure at 0.70 Condition W/m irradiance, 80 degrees C black panel temp.	ASTM D 4637 Conditions	No Cracks No Crazing

B. Submit written certification that the roof system, including the specific insulation, fasteners, adhesives, etc. have been tested in conjunction with the type of roof deck applicable to this project, and has achieved a Factory Mutual I-90 Wind Uplift rating and complies with peak gust wind speed rating in conformance with the codes in affect when project is permitted. Provide a

letter from Factory Mutual, or a copy of the Factory Mutual Approval Report for the roofing system.

C. Roofing System components are to be produced or supplied and approved by Membrane Manufacturer of the Roofing System in strict accordance with requirements of roofing system warranty, FM 1-90, and peak gust wind speed as indicated, and as herein specified.

2.4 INSULATION

A. Roof Insulation: Rigid closed cell polyisocyanurate foam, 3.0" thick R-19 minimum total thickness, unless otherwise indicated. Flame spread 0-75 (ASTM E84); FM Class 1; UL Class A with manufacturer's standard facers approved for compatibility by membrane manufacturer.

B. Tapered polyisocyanurate foam insulation, tapered to provide a minimum 1/8" per foot from the horizontal and to provide proper pitch for cants, gussets, etc. Flame spread 0-25 (ASTM E84); FM Class 1 U.L. Class A with manufacturer's standard facers approved for compatibility by membrane manufacturer.

C. Insulation for Crickets/Gussets: Rigid closed cell polyisocyanurate board; minimum 1/2” per foot slope where required for proper pitch, flame spread 0-25 (ASTM E84); FM Class 1; UL Class A with manufacturer's standard facers, Carlisle or approved equal.

D. Insulation Attachment: Mechanically fasten insulation using manufacturer’s approved fasteners placed at not less than 1 fastener with plat for every 2 square feet of insulation or as recommended by the manufacturer for attachment to the existing roof deck so as to comply with the manufacturer’s written warranty. As an alternate to mechanical attachment, the insulation can be attached or adhered to an acceptable substrate using the Roofing Membrane Manufacturer’s approved insulation Adhesive at no additional cost to the Client Agency. The insulation adhesive must be applied in strict accordance with the Roofing Membrane Manufacturer instructions.

2.5 MATERIALS

A. Membrane: Maximum 10 foot wide, 0.060 inch thick black EPDM membrane, equal to Carlisle Sure-Seal or approved equal. Fabricate to largest sheet size available as determined by job conditions. Based upon roof dimensions, membrane must have Factory-Applied Tape, wherever possible, secured to one edge to insure proper seam splicing. All joints shall be kept to a minimum.

B. Other components of roofing system such as bonding adhesives, splice cleaner, splicing cement, lap sealant, primer, splicing tape, cured EPDM flashing, pressure sensitive flashing, uncured elastoform flashing, seam fastening plates and .060 reinforced membrane flashing strips (RUSS, or approved equal) with corresponding fasteners, termination bars, insulation, water cut-off mastic, pourable sealers, walkway pads, pre-molded pipe seals, pressure-sensitive inside/outside corners, pipe seals, pourable sealer pockets, roof drains and piping etc. are required for this project and shall be products manufactured by or acceptable to and approved by the Primary Roofing Membrane Manufacturer in order to comply with performance and warranty requirements of this Project. Note, insulation and roof metal may be required through the primary roofing manufacturer in order to comply with the total system warranty requirements.

2.6 MISCELLANEOUS MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing membrane.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. System related materials: Adhesive, splice cleaner, splicing cement, in-seam sealant, lap sealant, primer, splicing tape, cured EPDM flashing, pressure sensitive flashing, elastoform flashing, termination bars, insulation fasteners, water cut-off mastic and pourable sealers, as required by roofing system manufacturer for compliance with project performance requirements and roof system warranty. Insulation, roof drains and piping as herein specified and roof metals as specified in Section 076300 Sheet Metal Flashing and Trim are also required for total system warranty and are subject to approval by the Architect and roofing system manufacturer.

C. Sponge Tubing or Solid Rod: Of type approved for use by flexible sheet roofing membrane manufacturer for movement control and expansion joints.

D. Pitch Pockets: For all conduit and pipe passing through roof shall be .015" stainless steel. Vertical leg of collar to be 6" with horizontal flange 6". Solder all joints.

E. Molded Walkway Pads: Molded walkway pads with slip resistant surface and factory rounded corners, 30” x 30” by approximately 0.30” in thickness including raised “nibs”.

F. Nails and Fasteners: Non-ferrous metal or galvanized steel, except that hard copper nails shall be used with copper; aluminum or stainless steel nails shall be used with aluminum; and stainless steel nails shall be used with stainless steel. Fasteners shall be self-clinching type of penetrating type as recommended by the manufacturer of the deck material. Nails and fasteners shall be flush-driven through flat metal discs of not less than one (1) inch diameter. Omit metal discs when one-piece composite nails or fasteners with heads not less than one (1) inch diameter are used.

G. Metal Discs: Flat discs or caps of zinc-coated sheet metal not lighter than twenty eight (28) gauge and not less than one (1) inch in diameter. Form discs to prevent dishing. Bell or cup shaped caps are not acceptable.

H. Non-Shrink Grout: Use an all weather fast setting chemical action concrete material to fill pitch pans.

1. Flexural Strength (ASTM C78 (modified)) 7 days 1100psi
2. High Strength (ASTM C109 (modified)) 24 days 8400lbs (3810kg)

I. Pitch Pocket Sealer: Two part, 100% solids, self leveling, polyurethane sealant for filling pitch pans as recommended and furnished by the membrane manufacturer.

1. Durometer (ASTM D2240) 40-50 Shore
2. Elongation (ASTM D412) 250%
3. Tensile Strength (ASTM D412) 200 @ 100 mil

2.7 METAL FLASHINGS & ACCESSORIES

A. Elastomeric flashing membrane width: Sufficient to extend onto horizontal roofing 6 inches minimum.

B. Aluminum Termination Bar: For flashing attachment, 1/8" x 1" extruded aluminum bar stock. Aluminum shall be an alloy suitable for a clear anodized finish. Maximum 8' lengths. Allow 1/4" clearance between all lengths of metal bar. Holes for anchoring screws are to be elongated horizontally 1/2" for expansion.

C. Edge flashing: Aluminum: ASTM B 209-96, alloy and temper - 3003-H14, mill finish. Thickness: 0.050 inches.

D. Counterflashing: Aluminum: ASTM B 209-96, alloy and temper - 3003-H14, mill finish. Thickness: 0.040 inches.

E. Expansion joint: Aluminum: ASTM B209-89, alloy and temper - 3003-H14, mill finish. Thickness: 0.050 inches.

F. Pitch pans with hood: Aluminum: ASTM B209-89, alloy and temper - 3003-H14, mill finish. Thickness: 0.040 inches.

G. Lead Flashings: ASTM B 29-92(1997), 4 lb. sheet lead.

H. Details not addressed in specification shall be in accordance with Architectural Sheet Metal Manual, as issued by Sheet Metal and Air Conditioning Contractors' National Association, Inc., (SMACNA).

2.8 SHEET METAL

A. Sheet Metal Flashing and Trim: Metal roof flashings, copings, conductor heads, gutters, downspouts, reglets, etc. shall be in accordance with roofing manufacturer’s written requirements for performance and warranty compliance. See Section 076200 – Sheet Metal Flashing and Trim.

2.9 WOOD BLOCKING & CURBS

A. Lumber: American Lumber Standard Committee (ALSC) No. 2 grade Southern Pine; free from warping and visible decay; pressure-treated according to AWPA Standard C2 for lumber and timber with CCA, ACA, ACQ-B, ACQ-D, ACZA, or CC to a retention of 4.0 kg/m^3 (0.25 pcf) for above ground use.

B. Wood blocking: 2" x 6" minimum.

C. Plywood sheathing: APA C-D, Plugged & Touch Sanded, Exposure 1, PS 1-83.
1. Thickness: 3/4 inch.
2. Wood cant: 4" x 4" cut on bias.
3. Free floating fascia cant: 2" x 4" cut on bias.

2.10 Gutters and Downspouts

A. Provide replacement of existing gutters and downspouts. Materials as indicated on the drawings.

2.11 Provide material certification of compliance.

PART 3 - EXECUTION

3.1 INSPECTION

A. It should be noted that no tests have been done to confirm the integrity of the Existing Roof Decks. The Contractor will be responsible to use whatever safety methods he deems suitable to protect workmen. Safety methods will be solely the Contractor's responsibility.

B. Installer shall verify soundness and condition of existing roof decks. Should defective areas be encountered, Installer shall immediately notify the Architect in writing of conditions detrimental to the safe, proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected. Beginning work of installing new roofing constitutes acceptance of conditions.

C. Remove all roofing at locations indicated, insulation, rotten nailers, blocking, cants, copings, flashings, gravel stops, ballast, etc., down to original deck. Examine structural roof deck, associated work, and conditions under which new roofing work is to be installed. Immediately report to Architect all significant deck damage or irregularities.

D. Verify that work of other trades penetrating roof deck or requiring men and equipment to traverse roof deck has been approved by Client Agency, roofing system manufacturer and roofing contractor.

E. Check projections, curbs, and deck for inadequate anchorage, foreign material, moisture, or unevenness that would prevent quality and execution of new roofing system.

F. Verify that deck surfaces and project conditions are ready to receive work of this Section.

G. Verify that deck is supported and secured to structural members.

H. Verify that deck is clean and smooth, free of depressions, projections or ripples, and is properly sloped to drains and scuppers.

I. Verify that adjacent roof substrate components do not vary more than 1/4 inch in height.

J. Verify that deck surfaces are dry.

K. Confirm that moisture content does not exceed 12 percent by moisture meter tests. On concrete deck, pour hot asphalt on to deck if it bubbles / foams and once cooled does not adhere to the substrate, the moisture levels are too high.

L. Verify that openings, curbs, pipes, conduit, sleeves, ducts, and other items which penetrate the roof are set solidly, and that cant strips, wood nailing strips and reglets are set in place.

3.2 DECK PREPARATION

A. Metal Deck

1. Verify that all welds are good, that deck is in plane and that it is free from damage and deflection.

B. Wood and Tectum Deck

1. Verify that all panels are structurally good, that deck is in plane and that it is free from damage and deflection.

3.3 PREPARATION OF SUBSTRATES

A. General: Comply with insulation and EPDM membrane manufacturers' written instructions for preparation of substrates to receive fully adhered insulation and EPDM membrane roofing system.

B. Verify that penetrations, expansion joints, and blocking are in place and secured and that roof drains are properly clamped into position.

C. Clean substrate so it is dry, relatively smooth, free of protrusions, dust, debris, sharp edges, other foreign materials, substances including accumulated water, ice and snow detrimental to EPDM roofing system work. Clean deck surface using compressed air, vacuum equipment or hand/power brooms to remove dust, loose dirt or debris. Where excessive dust or dirt is present, a primer may be required use prior to application of the adhesive. Notify the Roofing System Manufacturer in writing of existing conditions for specific requirements.

D. Fill cracks or voids in the substrate greater than 1/4” with roofing system manufacturer’s approved adhesive or other approved suitable material.

E. Install rubber fastening strips, flashings, and accessory items shown on approved shop drawings, and as recommended by the roofing system manufacturer.

F. Prevent compounds entering and clogging roof drains, downspouts, vents, etc. from spilling or migrating onto surfaces of other work.

3.4 INSTALLATION - GENERAL

A. Comply with UL requirements and with manufacturer's written design criteria requirements, specifications and technical manuals to prepare roof deck or substrate prior to application of the new roofing system, except where more stringent requirements are indicated and/or specified.

B. Begin application at the highest point of the highest roof level and work to the lowest point to prevent moisture infiltration and to minimize construction traffic on completed sections when feasible. This will include completion of all flashings and terminations.

C. Same day installation: Do not install more insulation/underlayment than can be covered by membrane and made watertight in the same day. Provide temporary water cut-offs and night seals to protect incomplete work in accordance with manufacturer's written requirements. Completely remove temporary water cut-offs prior to proceeding with work.

D. Deck shall be free of debris prior to installation of new materials. At no time shall the unprotected roof insulation be left exposed and subject to weather damage. Verify that penetrations, curbs and blocking are in place and secured and that roof drains are properly clamped in position.

3.5 WOOD NAILERS, BLOCKING, ETC.

A. Install treated wood nailers, blocking, etc., at locations indicated, detailed and required.

B. Nailers shall be firmly anchored to the decks at a maximum 2'-0" o.c., and shall resist a pullout force as required for FM I-90, at peak gust wind speed requirements indicated and Roofing Manufacturer's warranty requirements. A 1/2" vent space shall be provided between adjacent lengths of nailers. Fastening shall be in accordance with Factory Mutual Loss Prevention Data Sheet 1-49. Wood nailers shall be installed so that the top of the nailer is relatively flush with top surface of the membrane underlayment/insulation and that the width of the wood nailer exceeds the width of the metal flange (where applicable at edgings, scuppers, etc.) as indicated on approved shop drawings and in accordance with roofing system manufacturer's recommended details.

C. Secure wood nailers in accordance with roofing system manufacturer's written requirements and recommendations.

D. Roof edge:

1. Mechanically attach wood blocking. Offset blocking layers 12 inches; weave corners. Blocking thickness shall be equal to final insulation thickness including tapered edge strips.
2. Fasteners shall be installed in two (2) rows staggered. Spacing in any 1 row shall not exceed 24 inches. Within 8 feet of outside corners, spacing shall not exceed 12 inches in any one (1) row. Countersink fastener heads.
3. Install wood cants over roofing manufacturer's deck brackets. Nail two (2) rows at a spacing not to exceed 12 inches from each side of deck brackets. Miter corners.
4. Install wood cant at roof edge for raised metal edge fascia. Nail two (2) rows staggered. Spacing in any one (1) row shall not exceed 24 inches. Within 8 feet (2.4 meter) of outside corner, spacing shall not exceed 12 inches in any one (1) row.

E. Gutter edge:

1. Mechanically attach wood blocking. Offset blocking layers 12 inches weave corners. Blocking thickness shall be equal to final insulation thickness including tapered edge strips. Width shall be equal to or greater than flange width.

2. Fasteners shall be installed in two (2) rows staggered. Spacing in any one (1) row shall not exceed 24 inches. Within 8 feet of outside corners, spacing shall not exceed 12 inches in any one (1) row.

F. Wall flashings:

1. Mechanically attach wood blocking to flashing base.
2. Fasteners shall be installed in two (2) rows staggered. Spacing in any one (1) row shall not exceed 24 inches. Within 8 feet of outside corners, spacing shall not exceed 12 inches in any one (1) row.
3. Offset blocking layers 12 inches and weave corners. Blocking thickness shall be equal to final insulation thickness including tapered edge.

G. Expansion joint(s):

1. Install vertical blocking: Thickness shall be 2 inches, nominal. Height shall be 8 inches above final surface of roofing.
2. Install wood cants to blocking and substrate. Mechanically attach two (2) rows staggered to substrate and vertical blocking. Spacing in any one (1) row shall not exceed 24 inches).

H. Equipment stand (pipe) locations:

1. Mechanically attach wood blocking to deck at all equipment stand locations. Minimum 2 fasteners per section.
2. Offset blocking layers 12 inches and weave corners. Blocking thickness: Equal to final insulation thickness including tapered edge. Blocking width: 4 inches, nominal.

I. Wood curb locations:

1. Mechanically attach wood blocking to deck at all wood curb locations. Minimum 2 fasteners per section.
2. Offset blocking layers 12 inches and weave corners. Blocking thickness: Equal to final insulation thickness. Blocking width: 4 inches nominal.

J. Plumbing vents:

1. Mechanically attach wood blocking to structural deck at all plumbing vent locations, minimum 2 fasteners per section.
2. Offset blocking layers 12 inches and weave corners. Blocking thickness shall be 1-1/2 inches above final insulation thickness.

K. Pitch pocket locations:

1. Mechanically attach wood blocking to structural deck at all pitch pan locations, minimum 2 fasteners per section.
2. Offset blocking layers 12 inches and weave corners. Blocking thickness shall be equal to final insulation thickness including tapered edge. Width shall be 4 inches, nominal.

L. Wood blocking fastening pattern:

1. Secure continuous wood blocking with mechanical fasteners attached in two (2) rows staggered to substrate.

M. Parapet wall coping cap locations:

1. Mechanically attach continuous wood blocking to top of parapet using 1/2" diameter anchor bolts spaced 4 feet on center, with a minimum of 2 fasteners per section of wood blocking. Decrease anchor bolt spacing to two (2) feet on center in each direction 8 feet from the corner. Countersink anchor bolts flush with blocking surface.
2. Blocking thickness shall be 2 inches nominal.
3. Blocking width shall be flush with edges.

N. Nailer Strips: (not used on light weight insulating concrete decks and uninsulated decks) Mechanically fasten 4-inch nominal- (89-mm actual-) width wood nailer strips of same thickness as insulation perpendicular to sloped roof deck at the following spacing:

1. All slopes greater than 1-1/2:12 require back-nailing to prevent slippage of the ply sheets. Use ring or spiral shank one (1) inch cap nails, or screws and plates at the rate of one (1) fastener per ply (including the modified membrane) at each insulation stop. Place insulation stops at 16 feet on center for slopes less than 3:12. On non-insulated systems, nail each ply directly into the deck at the rate specified above. When slope exceeds 1-1/2:12, install all plies parallel to the slope (strapping) to facilitate back-nailing. Install four (4) additional fasteners at the upper edge of the modified bitumen sheet when strapping the plies.

3.6 INSULATION PLACEMENT AND ATTACHMENT

A. Insulation shall be attached in accordance with the insulation manufacturer's and primary roof membrane manufacturer’s current published specifications, details and recommendations for use with the existing roof decks complying with wind uplift criteria and the fully adhered roofing.

B. Butter all insulation boards together with no gaps greater than 1/4”. Gaps greater than 1/4” shall be filled with the same material.

C. Extend insulation full thickness in two or more layers, offsetting joints between layers, over entire surface to be insulated, cutting and fitting tightly around obstructions. Form cant strips, crickets, saddles, and tapered areas with additional material as shown as required for proper drainage of membrane.

D. Stagger joints in one direction for each course. For multiple layers, stagger joints in both directions between courses with no gaps to form a complete thermal envelope.

E. Secure roof insulation to substrate with roofing system manufacturer’s recommended and approved mechanical fastening system or insulation adhesive as indicated in approved submittals.

F. Insulation shall be neatly cut to fit around all penetrations and projections with a maximum allowable gap of 1/4".

G. Insulation shall be feathered or tapered to provide a sump area; minimum of 36" x 36" at all drains.

H. Upon completion of installation of insulation for each unit of work, and except as otherwise specified, cover immediately with membrane. Do not install more insulation per day than can be covered with membrane before end of day and before start of inclement weather.

3.7 MEMBRANE INSTALLATION

A. Install EPDM Membrane Roofing in accordance with approved shop drawings and in accordance with roofing system manufacturer's written requirements and instructions.

B. Ensure that water does not flow beneath any completed sections of the membrane system by completing all flashings, terminations and daily seals by the end of each work day.

C. Sweep all loose debris from the substrate.

D. Position membrane over acceptable substrate without stretching and allow to relax approximately 1/2 hour prior to bonding to substrate.

E. Fold membrane sheet back so half of the underside of the sheet is exposed. Sheet fold shall be smooth and without wrinkles.

F. Stir bonding adhesive thoroughly in accordance with manufacturer's written requirements. Bonding surfaces shall be dry and clean before application of adhesive.

G. Membrane shall be fully adhered to approved roofing insulation with adhesive supplied by the primary membrane manufacturer. Apply approved adhesive to the substrate and membrane to achieve continuous coating of both surfaces at a coverage rate of approximately 120 sq.ft. per gallon per one surface.

H. Allow adhesive to dry until it is tacky but will not string or stick to a dry finger.

I. Roll coated membrane into the coated substrate while avoiding wrinkles.

J. Brush down bonded membrane with a soft bristle brush to achieve maximum contact.

K. Install membrane overlaps to facilitate the flow of water where possible.

L. Adjoin sheets of membrane by overlapping a minimum 4" along the length of the membrane (at selvage edges) in preparation for membrane Factory-Applied Tape splicing. At end laps (along the width of the sheet), overlap membrane 2" to 1", which will be overlaid with 6" wide pressure-sensitive flashing or cured EPDM flashing. All splices shall be overlaid with 6 inch wide pressure-sensitive flashing or cured EPDM flashing.

M. Membrane splicing with Factory-Applied Tape:

1. Clean the splice area of the membrane contaminated by field dirt, adhesive or other residue.

2. Apply Roofing Membrane Manufacturer's Primer with a 1/2" medium nap roller to achieve a thin, even coat on both membrane surfaces. Splice area must be uniform in color, streak free and free of globs or puddles.
3. Allow Primer to dry until tacky but not allowing transfer to a dry finger touch.
4. Where Factory-Applied Tape is not present (i.e., base flashing details, cap sheet locations, etc.) unroll approximately 3' of SecurTAPE. Align release film with marked line and press tape down to bottom sheet using firm even hand pressure. Continue for the length of the splice. Tape roll ends must be overlapped 1". Allow top sheet to rest on release film on back side of the tape.
5. Pull release film from SecurTAPE beneath top sheet and allow top sheet to fall freely onto exposed tape.
6. Press the top sheet onto the tape using firm even hand pressure across the splice towards the splice edge.
7. Immediately roll the splice using positive pressure using a 2" wide steel roller, roll across the splice edge, not parallel to it. When using Stand-Up Seam Roller, splices may be rolled lengthwise along the splice.
8. Install a Pressure-Sensitive "T" Joint Cover or a 6" wide section (with rounded corners) of Pressure-Sensitive Flashing over all field splice intersections.

N. Flashing:

1. Flash all wall/curbs, etc., when feasible, with continuous deck membrane. When use of continuous deck membrane is not feasible, a separate piece of cured EPDM flashing or the primary EPDM membrane may be utilized.
2. Uncured elastoform flashing and pressure-sensitive uncured flashing shall be limited to overlaying vertical field seams, inside/outside corners, or other unusually shaped walls or penetrations; where the use of cured EPDM flashing, primary membrane, pressure sensitive flashing, or prefabricated accessories (pipe seals, pourable sealer pockets, corners) is not practical.
3. When using pressure sensitive flashing (semi-cured only) to overlay metal edging flanges, etc., primer shall be used to clean the membrane and metal surfaces. Apply lap sealant on straight runs of pressure sensitive flashing and around pressure-sensitive pipe seals.
4. Terminate flashing in accordance with manufacturer's approved termination detail. (Note: Remove fleece back lining from back of membrane prior to completing compression seal terminations and apply water cut-off mastic directly to the membrane surface.
5. Copings, counterflashing and other metal work, not provided by the primary membrane manufacturer shall be fastened to prevent the metal from pulling free or buckling and sealed to prevent moisture from entering the roofing system or building.

3.8 WALK-WAY PADS

A. Install Walk-way Pads at all traffic concentration points (i.e. roof hatches, access doors, rooftop ladders, mechanical and electrical rooftop equipment, etc. and paths in between). Provide and install walk-way pads/rolls per roofing membrane manufacturer's written requirements and recommendations. Provide a minimum 2" clearance space between pads to assure positive drainage.

3.9 PROTECTION

A. Institute all required procedures for protection of completed EPDM membrane roofing system and related work, throughout the remainder of construction. Do not allow traffic of any type on unprotected membrane.

END OF SECTION 075323.

SECTION 078413 - PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls, including both empty openings and openings containing penetrating items.

1.3 PERFORMANCE REQUIREMENTS

A. General: For penetrations through the following types of fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-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 through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. T-Rated Systems: For the following conditions, provide through-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 occupiable floor areas:

a. Penetrations located outside wall cavities.
b. Penetrations located outside fire-resistance-rated shaft enclosures.

C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provides products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-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 through-penetration firestop systems not requiring removal of insulation.

D. For through-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.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.

C. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.6 QUALITY ASSURANCE

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

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

D. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.

E. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements and those specified in Part 1 “Performance Requirements” Article:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in Part 1 “Performance Requirements” Article. Provide rated systems complying with the following requirements:

a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
b. Classification markings on penetration firestopping correspond to designations listed by the following:

1) UL in its "Fire Resistance Directory."

F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Client Agency's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by an approved inspecting agency and building official, if required by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Grace Construction Products.
2. Hilti, Inc.
3. Nelson Firestop Products.
4. Specified Technologies Inc.
5. Tremco, Inc.; Tremco Fire Protection Systems Group.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping 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.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping 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. Horizontal assemblies include shaftwall assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

E. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated. Accessories include, but are not limited to the following items:

1. Permanent forming/damming/backing materials, including the following:

   a. Slag-wool-fiber or rock-wool-fiber insulation.
   b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
   c. Fire-rated form board.
   d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.
2. Grade for Vertical Surfaces: Non-sag formulation for openings in vertical and other surfaces.

2.4 MIXING

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

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

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Client Agency will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

3.7 EXPLANATION OF UL SYSTEM NUMBERING METHOD

A. The format of the UL Listing Numbers for Firestop Systems Designs appearing in the UL Directory is Alpha – Alpha-Numeric, such as CAJ-1000 for example.

B. The first “Alpha” grouping uses the following characters to identify the type of penetrated fire separation:
1. “C” for both floor and wall penetrations
2. “F” for floor penetrations only
3. “W” for wall penetrations only

C. The second “Alpha” grouping uses the following characters to identify the type of construction:

1. “A” For concrete floors less than or equal to 5 inches thick (minimum)
2. “B” For concrete floors greater than 5 inches thick (minimum)
3. “C” For framed floors

4. "D" For deck construction
5. "E-I" Reserved for future use
6. "J" For concrete or masonry walls less than or equal to 8 inches thick (minimum)
7. "K" For concrete or masonry walls greater than 8 inches thick (minimum)
8. "L" For framed walls
9. "M" For bulkheads
10. "N-Z" Reserved for future use

D. The numeric grouping will use the following sequences of numbers for the penetrating items shown:

1. 0000-0999 None, No penetrating items.
2. 1000-1999 Metal pipe, conduit, or tubing.
3. 2000-2999 Non-metallic pipe, conduit, or tubing.
4. 3000-3999 Electrical cables.
5. 4000-4999 Electrical cables in a cable tray.
6. 5000-5999 Insulated pipes.
7. 6000-6999 Miscellaneous electrical penetrants such as bus ducts.
8. 6000-7000 Miscellaneous mechanical penetrants such as air ducts.
9. 8000-8999 Mixed penetrants containing any of the above.
10. 9000-9999 Reserved for future use.

3.8 PENETRATION FIRESTOPPING SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestopping with No Penetrating Items [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-L-].
2. UL Numbers: 0001-0999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Silicone sealant.
c. Intumescent putty.
d. Mortar.

C. Firestopping for Metallic Pipes, Conduit, or Tubing [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-K-] [W-L-] [W-N-].
2. UL Numbers: 1001-1999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Silicone sealant.
c. Intumescent putty.

d. Mortar.

D. Firestopping for Nonmetallic Pipe, Conduit, or Tubing [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-K-] [W-L-] [W-N-].
2. UL Numbers: 2001-2999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Silicone sealant.
c. Intumescent putty.
d. Intumescent wrap strips.
e. Firestop device.

E. Firestopping for Electrical Cables [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-K-] [W-L-].
2. UL Numbers: 3001-3999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Silicone sealant.
c. Intumescent putty.
d. Silicone foam.
e. Pillows/bags.

F. Firestopping for Cable Trays with Electric Cables [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [W-J-] [W-K-] [W-L-].
2. UL Numbers: 4001-4999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Intumescent putty.
c. Silicone foam.
d. Pillows/bags.
e. Mortar.

G. Firestopping for Insulated Pipes [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [C-BK-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-L-] [W-N-].
2. UL Numbers: 5001-5999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Intumescent putty.

c. Silicone foam.
d. Intumescent wrap strips.

H. Firestopping for Miscellaneous Electrical Penetrants [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [W-L-] [W-J-].
2. UL Numbers: 6001-6999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Intumescent putty.
c. Mortar.

I. Firestopping for Miscellaneous Mechanical Penetrants [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-L-] [W-N-].
2. UL Numbers: 7001-7999.
3. Type of Fill Materials: One or both of the following:

a. Latex sealant.
b. Mortar.

J. Firestopping for Groupings of Penetrants [FS-<#>]:

1. UL-Classified Systems: [C-AJ-] [C-BJ-] [F-A-] [F-B-] [F-C-] [F-E-] [W-J-] [W-L-].
2. UL Numbers: 8001-8999.
3. Type of Fill Materials: One or more of the following:

a. Latex sealant.
b. Mortar.
c. Intumescent wrap strips.
d. Firestop device.
e. Intumescent composite sheet.

END OF SECTION 078413

SECTION 079200 – JOINT SEALANTS

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. Silicone joint sealants
2. Urethane joint sealants
3. Latex joint sealants
4. Solvent-release-curing joint sealants
5. Preformed joint sealants
6. Acoustical joint sealants

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated used inside the weatherproofing system, including printed statement of 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.

D. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Pre-installation Conference: Conduct conference at Project site.

1.5 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.

1.6 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.

C. 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.

D. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food; provide products that comply with 21 CFR 177.2600.

E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT. Use at vertical surfaces and non-traffic horizontal surfaces such as, but not limited to, joints of exterior and interior precast panel joints, and exterior frames of windows, doors and louvers.

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. BASF Building Systems; Omniseal 50.
b. Dow Corning Corporation; 791
c. GE Advanced Materials – Silicones; SilPruf SCS2000
d. Pecora Corporation; 895.
e. Tremco Incorporated; Spectrem 2.

B. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use N. Uses: Interior sanitary applications, countertops, backsplashes, lavatories, plumbing fixtures.

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. Dow Corning Corporation; 999-A.
    b. GE Advanced Materials – Silicones; Construction SCS1200
    c. Pecora Corporation; 860.
    d. Tremco Incorporated; Proglaze, Tremsil 200.

C. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T. Self-leveling pavement joint sealant.

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. Dow Corning Corporation; 890-SL.
    b. Pecora Corporation; 300 SL, 310 SL.
    c. Tremco Incorporated; Spectrem 900 SL.

D. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT. For sealing ceramic tile joints and other nonporous substrates subject to in service exposures of high humidity and extreme temperatures.

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. GE Silicones; Sanitary 1700
    b. Pecora Corporation; 898.
    c. Tremco Inc., Tremsil 600 White

E. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT. Uses: Joints at tile and plumbing fixtures.

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. BASF Building Systems; Omniplus.
    b. Dow Corning Corporation; 786 Mildew Resistant
    c. GE Advanced Materials - Silicones; Sanitary SCS1700.
    d. Tremco Incorporated; Tremsil 200 Sanitary.

2.3 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT. Use for flashing and sheet metal joints and general purpose.

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. BASF Building Systems; Sonolastic NP1.
    b. Pecora Corporation; Dynatrol I-XL.
    c. Tremco Incorporated; Vulkem 116.

B. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T. Self-Leveling traffic sealant

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. BASF Building Systems; Sonolastic SL 1.
    b. Pecora Corporation; Urexpan NR-201.
    c. Tremco Incorporated; Vulkem 45.

C. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT. General Purpose

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. Pecora Corporation; Dynatrol II.
    b. Polymeric Systems, Inc.; PSI-270.
    c. Tremco Incorporated; Dymeric 240, Dymeric 240 FC.

D. Immersible, Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses T and I.

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. BASF Building Systems; Sonolastic NP1.
    b. Sika Corporation, Construction Products Division; Sikaflex - 1a.
    c. Tremco Incorporated; Vulkem 116.

2.4 LATEX JOINT SEALANTS

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

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. BASF Building Systems; Sonolac.

b. Pecora Corporation; AC-20+.
c. Tremco Incorporated; Tremflex 834.

2.5 SOLVENT-RELEASE-CURING JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealant: ASTM C 1311.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Bostik, Inc.; Chem-Calk 300.
b. Pecora Corporation; BC-158.
c. Tremco Incorporated; Tremco Butyl Sealant.

2.6 ACOUSTICAL JOINT SEALANTS

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pecora Corporation; AC-20 FTR, AIS-919.
b. USG Corporation; SHEETROCK Acoustical Sealant.
c. Tremco, Inc., Trimflex

2.7 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are non-staining; 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. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 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, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include, but are not limited to, the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.

4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include, but are not limited to, the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. 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.

F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.

G. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:

1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) inside masking tape.
3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

H. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

a. Perform 10 tests for the first 1000 feet (300 m) of joint length for each kind of sealant and joint substrate.
b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

a. Whether sealants filled joint cavities and are free of voids.
b. Whether sealant dimensions and configurations comply with specified requirements.
c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

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. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.

B. Related Sections:

1. Division 08 Section “Flush Wood Doors”.
2. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
3. Division 08 Section "Door Hardware".
4. Division 09 Sections "Exterior Painting" and "Interior Painting" for field painting hollow metal doors and frames.

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.

13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.
14. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
15. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
16. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

C. Shop Drawings: Include the following:

1. Elevations of each door design.
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.
4. Locations of reinforcement and preparations for hardware.
5. Details of anchorages, joints, field splices, and connections.
6. Details of accessories.
7. Details of moldings, removable stops, and glazing.
8. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Verification:

1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40” above sill) or UL 10C.

1. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
2. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted

temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

3. Smoke Control Door Assemblies: Comply with NFPA 105.

   a. Smoke "S" Label: Doors to bear “S” label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

D. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

   1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products from a SDI Certified manufacturer:

1. CECO Door Products (C).
2. Curries Company (CU).
3. Steelcraft (S).
4. Or approved equal

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
2. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
3. Manufactures Basis of Design

a. Curries Company CM Series
b. Curries Company M Series

C. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated

or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.

2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
3. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.5 LIGHT OPENINGS AND GLAZING

A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator’s shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.

C. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.

D. Preformed Metal Frames for Light Openings: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated. Match pre-finished door paint color where applicable.

E. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with the hollow metal door manufacturer's written instructions.

2.6 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.7 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Frames:

1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
2. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

    a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
7. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
8. Electrical Knock Out Boxes: Factory weld 18 gauge electrical knock out boxes to frame for electrical hardware preps; including but not limited to, electric through wire transfer hardware, electrical raceways and wiring harnesses, door position switches, electric strikes, magnetic locks, and jamb mounted card readers as specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".

    a. Provide electrical knock out boxes with a dual 1/2-inch and 3/4-inch knockouts.
    b. Conduit to be coordinated and installed in the field (Division 26) from middle hinge box and strike box to door position box.
    c. Electrical knock out boxes to comply with NFPA requirements and fit electrical door hardware as specified in hardware sets in Division 08 Section "Door Hardware".
    d. Electrical knock out boxes for continuous hinges should be located in the center of the vertical dimension on the hinge jamb.

9. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
10. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

        1) Two anchors per jamb up to 60 inches high.
        2) Three anchors per jamb from 60 to 90 inches high.
        3) Four anchors per jamb from 90 to 120 inches high.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

11. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".

D. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

2.8 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

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. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

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

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

END OF SECTION 081113

SECTION 087100 – DOOR HARDWARE

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. This Section includes commercial door hardware for the following:
   1. Swinging doors.
   2. 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 – BEST key core lock system.

C. 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.

D. Standards: All hardware specified herein shall comply with the following industry standards:
   1. ANSI/BHMA Certified Product Standards - A156 Series
   2. UL10C – Positive Pressure Fire Tests of Door Assemblies

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. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
b. Complete (risers, point-to-point) access control system block wiring diagrams.
c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the Client Agency 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. Client Agency must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

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. 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.

C. 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 Client Agency concerning both standard and electromechanical door hardware and keying.

D. 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.
   2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. 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.

G. 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

H. 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 Client Agency via registered mail or overnight package service. Instructions for delivery to the Client Agency 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 Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. 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 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. 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 Client Agency. 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. Seven years for heavy duty cylindrical (bored) locks and latches.
   2. Five years for exit hardware.
   3. Five years for motorized electric latch retraction exit devices.
   4. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Client Agency'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. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
1. Permanent cylinders, cores, and keys to be installed by Client Agency.

D. 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, Client Agency, 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 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.
4. Manufacturers:
a. Bommer Industries (BO).
b. Hager Companies (HA).
c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers:
a. Bommer Industries (BO).
b. Hager Companies (HA).
c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
d. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

2.3 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.

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
   1. Manufacturers:
      a. BEST key core locking system
      b. Schlage
C. Cylinders: Original manufacturer cylinders complying with the following:
   1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
   2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
   3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
   4. 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.
   5. Keyway: Match Facility Standard.
D. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
   1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (small or large format) as specified in Hardware Sets.
E. Keying System: Each type of lock and cylinders to be factory keyed.
   1. Conduct specified "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 Client Agency.
   3. Existing System: Key locks to Client Agency's existing system.
F. 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).
G. Construction Keying: Provide temporary keyed construction cores.
H. Key Registration List (Bitting List):
   1. Provide keying transcript list to Client Agency'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 Client Agency.

2.4 MECHANICAL LOCKS AND LATCHING DEVICES

A. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Grade 1 certified.
   1. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
   2. Locks are to be non-handed and fully field reversible.
   3. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.2 requirements to 2 million cycles.
   4. Manufacturers:
      a. BEST key core locking system
      b. Sargent Manufacturing (SA) – 10 Line.
      c. Schlage ND

2.5 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.

2.6 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 including installation and adjusting information on inside of cover.
   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. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
   4. 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 physically handicapped, provide units complying with ANSI ICC/A117.1.
   5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
   6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
   7. 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 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. Sargent Manufacturing (SA) - 351 Series.
      b. Norton Door Controls (NO) - 7500 Series.

2.7 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. Burns Manufacturing (BU).
      b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
      c. Trimco (TC).

2.8 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. Burns Manufacturing (BU).
      b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
      c. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
   1. Manufacturers:
      a. Architectural Builders Hardware (AH).
      b. Rixson Door Controls (RF).
      c. Sargent Manufacturing (SA).

2.9 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. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
   2. Reese Enterprises, Inc. (RE).
   3. Zero (ZE).

2.10 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.

2.11 FINISHES – Match existing

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: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

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 Client Agency occupancy.

3.7 DEMONSTRATION

A. Instruct Client Agency'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 Client Agency 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.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer’s Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. SA - Sargent
4. RO - Rockwood
5. RF - Rixson
6. NO - Norton
7. SU – Securitron
8. SC - Schlage
9. OT - OTHER

Hardware Sets

Set: 1.0

Doors: Allowance for 4 sets

3	Hinge (heavy weight)	T4A3386 NRP	US32D	MK
1	Storeroom Lock	DG164 8204 LNMD	US32D	SA
1	Core	BEST key core locking system	US15	SA
1	Surface Closer	R/PR7500 to suit conditions	689	NO
1	Kick Plate	K1050 10" high BEV CSK	US32D	RO
1	Door Stop	471 EXP	US26D	RO

1	Threshold	171A	PE
1	Gasketing	S773BL	PE
1	Sweep	315CN	PE

END OF SECTION 087100

SECTION 089119 - FIXED LOUVERS

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. Fixed, extruded-aluminum louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver: Louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

C. Samples: For each type of metal finish required.

1.5 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."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 FIXED, EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Drainable-Blade Louver:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Airolite Company, LLC (The).
b. American Warming and Ventilating; a Mestek company.
c. Construction Specialties, Inc.
d. Greenheck

2. Louver Depth: 6 inches (100 mm).
3. Blade Profile: Plain blade without center baffle.
4. Frame and Blade Nominal Thickness: .125”.
5. Mullion Type: Exposed.
6. Louver Performance Ratings:

a. Free Area: Not less than 8.5 sq. ft. (0.79 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
b. Point of Beginning Water Penetration: Not less than 900 fpm (3.6 m/s).

2.3 LOUVER SCREENS

A. General: Provide screen at each louver.

1. Screen Location for Fixed Louvers: Interior face.

2. Screening Type: Bird screening.

B. Secure screen frames to louver frames with stainless-steel machine screws, spaced a maximum of 6 inches (150 mm) from each corner and at 12 inches (300 mm) o.c.

C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.

1. Metal: Same type and form of metal as indicated for louver to which screens are attached
2. Finish: Mill finish unless otherwise indicated.
3. Type: Non-rewirable, U-shaped frames.

D. Louver Screening for Aluminum Louvers:

1. Bird Screening: Aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.60-mm) wire.

2.4 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), 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. Use Phillips flat-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening galvanized steel, use hot-dip-galvanized steel or 300 series stainless-steel fasteners.
4. For fastening stainless steel, use 300 series stainless-steel fasteners.
5. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.

F. Provide subsills made of same material as louvers or extended sills for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.6 ALUMINUM FINISHES

A. Finish louvers after assembly.

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

1. Color: As selected by Architect from full range of industry colors and color densities.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

END OF SECTION 089119

SECTION 092900 - GYPSUM BOARD ASSEMBLIES

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 DESCRIPTION OF WORK

A. Provide all labor, materials, accessories, equipment, incidentals to complete gypsum board assembly work, as indicated and required including, but not necessarily limited to, the following:

1. Interior Gypsum Wallboard.
2. Non-Load-Bearing Steel Framing and Furring for gypsum board assemblies.
3. Soffit Suspension System.
4. Accessories and trim.
5. Taping and Spackling.
6. Special corner finishing units for gypsum board assemblies, designed to bond structurally with gypsum panels to prevent cracks.
7. Reinforcing and blocking to receive and support the work of other trades.
8. Building in items furnished by other trades and/or contracts.

B. Related Work Specified Elsewhere:

Cold Formed Metal Framing: Division 5
Rough Carpentry: Division 6
Painting: Division 9

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide non-load-bearing gypsum board wall and partition assemblies capable of withstanding uniform load of 5 lbf/sq. ft. over entire wall for heights of partitions indicated without failing.

1. Deflection Limit: L/360, unless otherwise indicated; L/600 for gypsum board assemblies with ceramic tile facing.
2. Provide framing member size, thickness and spacing, and supplemental bracing as necessary to comply with manufacturer's published recommendations for conditions of installation and performance requirements.

1.4 ACTION SUBMITTALS

A. Submit manufacturer's product data and installation instructions for each type of product indicated.

B. Shop Drawings showing layout, locations, fabrication, and installation of all control and expansion joints including plans, elevations, sections, details of components and attachments of other units of work including concealed blocking.

C. Submit ceiling grid system, framed ceiling suspension system, and soffit suspension system layout drawings, to scale, showing spacing, dimensions of members, direction of main runners, edge conditions where abutting other surfaces, seismic bracing details, custom trim and ceiling opening locations including; location of diffusers, grilles, lighting fixtures, smoke detectors, sprinklers, and other items.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory", or in Gypsum Association GA-600 "Fire Resistance Design Manual".

B. Comply with the requirements of the following:

1.	ASTM C 36	"Standard Specification for Gypsum Wallboard."
2.	ASTM C 474	"Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction."
3.	ASTM C 475	"Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board."
4.	ASTM C 645	"Standard Specification for Nonstructural Steel Framing Members."
5.	ASTM C 754	"Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products."
6.	ASTM C 840	"Standard Specification for Application and Finishing of Gypsum Board."
7.	ASTM C 919	"Standard Specification for Use of Sealants in Acoustical Applications."
8.	ASTM C 954	"Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inches (0.84 mm) to 0.112 in. (2.84 mm) in thickness."
9.	ASTM C 1002	"Standard Specification for Specification for Steel Drill Screws for the Application of Gypsum Panel or Metal Plaster Bases."
10.	ASTM C 1047	"Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base."
11.	GA-216	"Recommend Specifications for the Application and Finishing of Gypsum Board."

C. Sound Rated Assemblies: Provide materials and construction identical to assemblies indicated and in accordance with ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency to achieve the STC Rating indicated, or if not indicated, a minimum STC Rating of 50.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original unopened containers, packages or bundles bearing brand name and identification of manufacturer or supplier.

B. Use or develop a written plan for the management of the jobsite for the delivery, storage, installation and protection of the products until completion of the project.

C. Store materials inside under cover and in manner to keep them dry, protected from direct exposure to rain, snow, condensation, direct sunlight, surface contamination, corrosion, damage, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

D. Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal corner beads and trim from being bent or damaged.

1.7 PROJECT CONDITIONS

A. Comply with ASTM C 840 and ASTM C 843 (veneer plaster) requirements gypsum board manufacturer's written recommendations, whichever are more stringent, for environmental conditions before, during and after application of gypsum board and plaster skim coat construction work.

B. Environmental Limitations: Room temperatures shall be maintained at not less than 50 degrees F, during application of gypsum board for a minimum period of 48 hours prior to, during and following application of gypsum board, joint treatment materials and bonding of adhesives.

C. Further maintain not more than 80 degrees F (27 deg C) for 7 days prior to application of gypsum base and plaster skim coat, continuously during application, and after application until plaster skim coat is dry.

D. Avoid exposure to excessive, repetitive or continuous moisture, before, during, and after installation. Eliminate sources of moisture immediately.

E. Ventilation: Adequate ventilation shall be maintained in the work area of building spaces as required to remove water in excess of that required for drying of joint treatment material and plaster skim coat during installation and curing period. Avoid drafts during dry, hot weather to prevent too rapid drying.

F. Do not install interior gypsum panels until installation areas are enclosed and conditioned.

G. Do not install panels that are wet, moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.

H. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following; or approved equal:

1. Metal Support Materials:

a. Dale/Incor, Inc.
b. National Gypsum Co.
c. Dietrich Industries, Inc.
d. Unimast, Inc.

2. Gypsum Board and Related Products:

a. Georgia-Pacific Corp.
b. Gold Bond Building Products Div., National Gypsum Co.
c. United States Gypsum Co.

3. Deflection Track and Clips:

a. The Steel Network, Inc.
b. approved equal

2.2 STEEL PARTITION AND SOFFIT FRAMING SYSTEMS

A. Framing Members, General:

1. Comply with ASTM C 754 for conditions indicated.
2. Steel Sheet Components: Complying with ASTM C 645 requirements for metal and with ASTM A 653, G40, hot-dip galvanized zinc coating.

B. Metal Studs: ASTM C645; 0.0329 (20 gauge) min. thickness of base metal or heavier if required by referenced standards to support indicated loads within maximum deflections specified. Hot dipped galvanized per ASTM A 653, G 40, G60 at toilet rooms and shower areas. Depth 3-5/8 inches unless otherwise indicated.

C. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

1. Dimpled Steel Studs and Runners:

    a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm) unless otherwise indicated.
    b. Depth: 3-5/8 inches (92 mm) unless otherwise indicated.

D. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
        2) MBA Building Supplies; FlatSteel Deflection Track or Slotted Deflecto Track.
        3) Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.
        4) Superior Metal Trim; Superior Flex Track System (SFT).
        5) Telling Industries; Vertical Slip Track or Vertical Slip Track II.

E. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
    b. Grace Construction Products; FlameSafe FlowTrak System.
    c. Metal-Lite, Inc.; The System.
    d. Steel Network Inc. (The); VertiClip SLD or VertiTrack VTD Series.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).

G. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: 1-1/2 inches (38 mm) unless otherwise indicated.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm) unless otherwise indicated.
2. Depth: 7/8 inches (38 mm) unless otherwise indicated.

I. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped unless otherwise indicated.

J. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

1. Depth: 3/4 inch (19 mm) unless otherwise indicated.
2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

K. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 INTERIOR GYPSUM WALLBOARD

A. Panel Size: Provide panels in maximum lengths and widths available that will minimize joints in each area and correspond with the support system indicated.

B. Gypsum Wallboard: ASTM C-36; tapered edges, Type X for fire resistance rated assemblies.

1. Smooth Regular Faced Gypsum Wallboard: 5/8” thick, unless otherwise indicated, with long ends tapered. Use Type X where required for fire resistance rated assemblies.

2. Interior Gypsum Ceiling Board: 5/8” thick, unless otherwise indicated, manufactured with a special gypsum core containing additives to offer greater support and sag resistance for water based spray texture paints and insulation than 5/8” standard regular-type panels. Use Type X where required for fire resistance rated assemblies.

C. Abuse-Resistant Gypsum Board: ASTM C-36; tapered edges, Type X for fire resistance rated assemblies.

1. Smooth Regular Faced Gypsum Wallboard: 5/8” thick, unless otherwise indicated, with long ends tapered. Use Type X where required for fire resistance rated assemblies.

2. Surface Abrasion, Indentation, and Soft body Impact: ASTM C 1629/C 1629M, meets or exceeds Level 1 requirements.

3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

4. Gold Bond HI-ABUSE XP with M2TECH

D. Interior Flexible Gypsum Wallboard: ASTM C 1396/C1396M, 1/4” thick, unless otherwise indicated, manufactured to bend to fit tight radii and to be more flexible than standard regular-

type panels of the same thickness, with long ends tapered. Apply in double layer at curved assemblies unless additional layers are indicated.

E. Extreme Impact Resistant Drywall with M2TECH

2.4 TILE BACKING PANELS

A. Panel Size: Provide panels in maximum lengths and widths available that will minimize joints in each area and correspond with the support system indicated.

B. Glas-Mat Water Resistant Backing Board: ASTM C 1178/C 1178M, 5/8" thick, unless otherwise indicated, Fiberglass mat faced gypsum tile backer board consisting of a noncombustible, silicone-treated core with a moisture resistant material surface on face and back with fiberglass fiber mat and moisture resistant coating with square edges. Use Type X where required for fire resistance rated assemblies. "Dens-Shield" by Georgia Pacific or approved equal.

C. Water-Resistant Gypsum Wallboard for use at toilet rooms, locker rooms: 5/8" thick, unless otherwise indicated, manufactured with a special water resistant core and faced with chemically treated multi-layered face and back papers to combat moisture penetration, with long ends tapered, green finish paper. Use Type X where required for fire resistance rated assemblies.

D. Cementitious Backer Units: ANSI A 118.9, 1/2" thick, unless otherwise indicated. Durock by United States Gypsum or approved equal.

2.5 TRIM ACCESSORIES

A. Interior Trim:

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc, except as otherwise indicated, ASTM C 1047
2. Shapes:

    a. Expansion (control) joint.
    b. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Trim at exposed outside corners: Aluminum extrusion.

1. Cornerbead: Factory primed extruded aluminum high strength corner, square profile, Model SO-HSE-90 by Pittcon Softforms or approved equal. Use at all exposed outside gypsum board corners unless noted otherwise.

C. Self-Masking Trim: PVC edge moldings with removable protective strip.

1. Use at exposed panel edges where gypsum board abuts other materials.
2. Manufacturers: Subject to compliance with requirements, provide products one of the following:

a. Fast Mask S-100; Flannery Inc.
b. Peel Away Angle; A-Z Bogart Inc.
c. Ceiling Trim No. 22 Vinyl Tech; Plastic Components Inc.

2.6 JOINT TREATMENT MATERIALS

A. Joint Treatment Materials: Comply with ASTM C 475 and recommendations of manufacturer.

B. Joint tape:

1. Use perforated paper type for interior wallboard unless otherwise recommended by the panel manufacturer.

C. Joint compound: Comply with ASTM C 475 and recommendations of the manufacturer.

1. For interior gypsum wallboard use setting-type taping compound followed by coats of setting-type sandable topping compound or as otherwise recommended by manufacturer.

D. Concealed Acoustical Sealant: Non-drying, non-hardening, non-skinning, non-staining, non-bleeding, gunnable synthetic rubber sealant recommended for sealing interior concealed applications per ASTM C 919.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Plaster Bonder: For bonding new plaster to any structurally sound interior surface of the type recommended by the drywall/veneer plaster manufacturer.

D. Spot Grout: ASTM C 475, setting-type joint compound recommended for spot grouting steel door frames, transoms, side lites and borrowed lites.

E. Fastening Adhesive for Metal: Special adhesive recommended for laminating gypsum panels to steel framing.

F. Steel Drill Screws: ASTM C 1002.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.

G. Framing screws: ASTM C 646 - Corrosion Resistant.

H. Power actuated fasteners: Type recommended by manufacturer for securing runners and furring strips to masonry and concrete.

I. Steel drill screws: ASTM C 954 - Corrosion Resistant for fastening panels to steel members.

J. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.
3. Sound Attenuation Blankets: Use thermal batt insulation sized for full depth of stud thickness, as specified in Division 07 Section “Thermal Insulation”

K. Acoustical Sealant for Exposed and Concealed Joints: Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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

a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
b. United States Gypsum Co.; SHEETROCK Acoustical Sealant.

L. Acoustical Sealant for Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

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

a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
b. Pecora Corp.; AIS-919.
c. Tremco, Inc.; Tremco Acoustical Sealant.

M. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

PART 3 - EXECUTION

3.1 INSPECTION

A. Installer must examine the areas and conditions under which gypsum board assembly work is to be installed and notify the General Contractor 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.

B. Thermal Barrier: All foam plastic insulation shall be separated from the interior of a building by metal roof deck or by 1" minimum thickness of masonry or concrete. Where separation is less than 1" of masonry or concrete, provide an approved thermal barrier of not less than 1/2" gypsum wallboard or equivalent in compliance with ASTM E119. Thermal barrier shall be installed such that it will stay in place for a minimum of 15 minutes.

3.2 PREPARATION FOR METAL FRAMING

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, wire shelving, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook.

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.

a. Use proprietary deflection track except as otherwise indicated.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

F. Firestop Tracks: Install to maintain continuity of fire-resistance-rated assembly indicated.

G. Sound-Rated Shaft Wall Assemblies: Seal with acoustical sealant at perimeter of each assembly and at joints and penetrations.

H. Remove and replace panels that are wet, moisture damaged, or mold damaged.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacing indicated, but not greater than spacing required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

E. Furring Members:

1. Erect insulation, specified in Division 07 Section "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 WALLBOARD INSTALLATION

A. Installation of gypsum board products shall be in accordance with ASTM C 840 “Standard Specification for Application and Finishing of Gypsum Board”, and GA-216.

B. Inspect all surfaces and framing to which gypsum wallboard is to be applied. Remedy all conditions that will jeopardize satisfactory finish walls prior to installation of drywall. Check alignment and plumb of all framing and furring.

C. Install thermal blankets to full thickness of stud depth in lieu of acoustical batts as indicated, and in accordance with insulation manufacturer’s recommendations for installation and attachment, prior to gypsum panels unless readily installed after panels have been installed on one side.

D. Install appropriate gypsum panel perpendicular to the framing and up against the floor and metal deck. Use the correct type and length of fastener, including spacing to meet the intended fire resistance rating. Install panels on both sides of the metal framing unless otherwise indicated.

E. Install gypsum soffit and ceiling boards across framing to minimize the number of abutting end joints and avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

F. Install single layer wallboard assemblies horizontally with Type "S" Bugle head drywall screws spaced not more than 12" o.c. Stagger joints on both sides of two sided partitions. Tightly install thermal batt insulation as indicated between studs. Butt boards together for a light contact at edges and ends with not more than 1/16" open space between boards. Do not force into place.

G. Position boards so that like edges abut, tapered edges against tapered edges and mill-cut field-cut ends against mill-cut or field-cut ends. Do not place tapered edges against cut edges or ends. Stagger vertical joints over different studs on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

H. Install gypsum board with face side out. Do not install imperfect, damaged, or damp panels. Butt panels together for a light contact at edges and ends with not more than 1/16-inch open space between panels. Do not force into place.

I. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories. Spacing of control and expansion joints shall be as shown and/or in accordance with the gypsum board manufacturer’s written recommendations.

J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations, and trim edges with L-bead edge trim where edges of gypsum panels are exposed.

K. Install in maximum practical lengths to span wall and ceiling framing without end (butt) joints. If butt joints do occur, stagger joints and locate as far as possible from center of walls and ceilings.

L. Sound-Insulated Assemblies: Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

    1. Penetrations in assemblies include, but are not limited to, ducts, pipes, conduits, electrical boxes, outlets and switches.

M. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

    1. Space screws a maximum of 12 inches o.c. for vertical applications.

N. Cut openings in gypsum board to fit items to be built in, including electrical outlets, accessories, etc. Openings shall fit snugly and shall be small enough to be covered by plates and escutcheons. Both face and back paper shall be cut for all cutouts that are not made by use of a saw. Support gypsum board securely around all cutouts and openings.

O. Allow the other trades to install the needed services (MEP) through the gypsum board.

P. Install all required through stop penetrations. Continue installing the remaining gypsum panels to complete the wall in accordance with the fire rated design.

Q. Install fasteners not more than 1" and no closer than 3/8" to end or edges. Space fasteners opposite each other on adjacent ends or edges. Begin fastening from center of wallboard and proceed toward outer end of edges. Apply pressure on wallboard adjacent to fasteners being driven to ensure that wallboard will be secured tightly to framing members. Check for looseness at fastener. Drive fasteners with shank reasonably perpendicular to face of board. Drive screws with a power screwdriver of type recommended by the wallboard manufacturer. Surface of head shall be below surface of paper without cutting paper. Apply acoustic sealant at all penetrations for electric receptacles, switches, wire, piping, ductwork and other applicable sources of sound transmission.

R. Pack voids in steel door and lite frames and the like, etc. with sound attenuation.

3.6 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than one framing member in alternate courses of board.
    b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

B. Multilayer Application on Ceilings: Apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

C. Multilayer Application on Partitions/Walls: Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

D. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

E. Multilayer Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

1. Where required for fire-resistance ratings, fasten base layers and face layers separately to supports with screws.

F. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum

board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.7 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings and according to ASTM C 840, in specific locations approved by Architect for visual effect.

3.8 FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated.

1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated.
2. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated.
3. Level 5: Provide diluted skim coat mixture of joint compound and water on entire surface of gypsum board after completion of level 4 finish. Compound should not be too thin or runny. Remove excess compound to create uniform thin layer on entire surface of gypsum board. Sand if necessary to achieve even smooth surface for painting. After finishing and painting, no differential light reflection should be seen from oblique angles.
   a. Provide level 5 finish through entire area of elevator lobbies.

3.9 ACCESSORY INSTALLATION

A. General: Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to the supports. Otherwise, fasten flanges by nailing or stapling in accordance with manufacturer's instructions and recommendations.

B. Install metal corner beads at external corners of drywall work.

C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed, and except where plastic trim is indicated. Provide type with face flange to receive

joint compound except where semi-finishing type is indicated. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work kerfed to receive long leg of L-type trim. Install U-type trim where edge is exposed, revealed, gasketed, or sealant-filled (including expansion joints).

D. Install J-type semi-finishing trim where gypsum board edges are not covered by applied moldings.

E. Omit fastening wallboard closer than one support away from area where casing trim will be installed. Insert metal flange between wallboard and bearing surface, and move in until properly aligned. Fasten wallboard through metal flange before bedding perforated tape.

F. Maintain metal edge in a true line.

3.10 JOINT TREATMENT

A. Apply bedding compound to edge and end joints and to fastener heads. Use types as recommended by gypsum manufacturer for use with gypsum product being installed. Shear off surplus leaving a tapered groove for embedding tape. Leave no material on high edge. Allow 12 hours for drying before taping.

B. Apply a uniformly thin layer of bedding compound over the joint approximately 4" wide. Center tape over joints and embed into compound.

C. Allow compound to dry thoroughly for approximately 24 hours. Cover tape with a coat of compound and spread out 3" on each side of tape. Feather out at edges.

D. After preceding coat is thoroughly dry, apply another coat with slight uniform crown over joints. This coat must be smooth and with edges feathered out 3" beyond preceding coat.

E. All fastener heads and dimples shall receive at least three (3) coats of compound. Apply as each coat is applied to joints, allowing at least 24 hours between each coat.

F. Cover flanges of beads and trim with at lease two (2) coats of compound. First layer shall be bedding compound. Apply along with respective coats of compound on joints. Feather out compound approximately 9" from metal bead.

G. Sand coats of compounds when thoroughly dry and sanding is needed. Avoid roughing surface of gypsum board product.

H. Leave wallboard uniformly smooth and ready for decoration.

3.11 PROTECTION OF WORK

A. Provide temporary protection to installed panels, such as tarps, as required. The intent is to protect the gypsum panels in those areas where, when installed, exhibit increased potential for impingement by water in its liquid state. Protect from cascading water.

B. Provide final protection and maintain conditions, in a manner suitable to installer, which ensures gypsum board assembly work being without damage or deterioration at time of substantial completion.

END OF SECTION 092116

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

Also known as Acoustical Ceiling Tile (ACT) System.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Product test reports.

C. Research reports.

D. Field quality-control reports.

1.4 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: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide ACT Armstrong Ceiling Solutions, ULTIMA Square Lay-in Acoustical Panel Item No. 1910; ACT in secure areas of the first and second floor provide 1" Armstrong Tectum Finale Ceiling Panels; ACT-1 in non-secure areas of Basement provide Armstrong CORTEGA 704; or comparable product by one of the following:

1. CertainTeed Corporation.
2. United States Gypsum Company.

B. Acoustical Panel Standard: Manufacturer's standard panels according to ASTM E 1264.

C. Classification: Type IV, Form 2, Pattern E.

D. Color: White

E. Light Reflectance (LR): .90.

F. Ceiling Attenuation Class (CAC): 35.

G. Edge/Joint Detail: Square

H. Thickness: 3/4 inch (19 mm).

I. Modular Size: 24 by 24 inches.

2.3 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Ceiling Solutions, Prelude XL Exposed Tee Suspension System or comparable product by one of the following:

1. CertainTeed Corporation.
2. United States Gypsum Company.

B. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M.

C. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel or aluminum.
5. Cap Finish: Painted white

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Hold-Down Clips: Manufacturer's standard hold-down.

C. Impact Clips: Manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Basis-of-Design Product: Subject to compliance with requirements, provide Armstrong Ceiling Solutions, or comparable product by one of the following:

1. CertainTeed Corporation.
2. United States Gypsum Company.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated.

B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Do not use exposed fasteners, including pop rivets, on moldings and trim.

2. Install hold-down and impact clips in areas indicated; space ac-

cording to panel manufacturer's written instructions unless otherwise indicated.

END OF SECTION 095113

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl base.
2. Vinyl molding accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 - PRODUCTS

2.1 VINYL BASE

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

1. Armstrong World Industries, Inc.
2. Johnsonite, A Tarkett Company.
3. Roppe Corporation, USA.

B. Product Standard: ASTM F 1861, Type TV (vinyl, thermoplastic).

1. Group: I (solid, homogeneous).
2. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with resilient floor coverings.

C. Minimum Thickness: 0.125 inch (3.2 mm).

D. Height: 4 inches (102 mm).

E. Lengths: coils in manufacturer's standard length.

F. Outside Corners: Preformed.

G. Inside Corners: Preformed.

H. Colors and Patterns: Black.

2.2 VINYL MOLDING ACCESSORY

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

1. Armstrong World Industries, Inc.
2. Johnsonite, A Tarkett Company.
3. Roppe Corporation, USA.

B. Description: Vinyl carpet edge for glue-down applications, reducer strip for resilient floor covering, joiner for tile and carpet and transition strips.

C. Profile and Dimensions: As indicated.

D. Locations: Provide vinyl molding accessories in areas indicated.

E. Colors and Patterns: As selected by Architect.

2.3 INSTALLATION MATERIALS

A. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Do not install resilient products until materials are the same temperature as space where they are to be installed.

3.2 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Preformed Corners: Install preformed corners before installing straight pieces.

3.3 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl composition floor tile.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and pattern specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 VINYL COMPOSITION FLOOR TILE

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

1. Armstrong World Industries, Inc.
2. Congoleum Corporation.
3. Johnsonite: a Tarkett Company.
4. Mannington Mills, Inc.

B. Tile Standard: ASTM F 1066, Class 1, solid color.

C. Wearing Surface: Smooth.

D. Thickness: 0.125 inch (3.2 mm).

E. Size: 12 by 12 inches (305 by 305 mm).

F. Colors and Patterns: As selected by Architect from manufacturers full product offerings.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. (18.6 sq. m) and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.2 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis.

C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction.

D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.

G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

H. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.

1. Apply two coats.

END OF SECTION 096519

SECTION 099000 – PAINTING AND COATING

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 DESCRIPTION OF WORK

A. Provide all plant, labor, materials, accessories, equipment and incidentals required to complete Painting and Coating work, including but not necessarily limited to, the following:

1. Surface preparation, priming and finish painting and coating of surfaces, except as otherwise specified.
2. Multiple colors, patterns, borders, fields and designs as indicated and/or selected by the Architect.
3. Finish painting and coating primed surfaces, except as otherwise indicated.
4. Exposed to view structural steel, joists, decking, lintels, covered and bare pipes and ducts (including color coding), hangers and the like along with primed metal surfaces of mechanical and electrical equipment, unless otherwise indicated, are to be painted and are included in the work of this section.
5. Do not paint prefinished items, conceal surfaces, finished metal surfaces, operating parts and labels.
6. Where touch-up painting and coating work is required, re-finish the entire surface plane.
7. All other surfaces, not specifically noted, that require painting or coatings.

B. Paint or coat exposed surfaces, except where the finish schedule indicates that a surface or material is not to be painted, coated or is to remain natural. If the schedules do not specifically mention an item or a surface, paint or coat the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.

1. Painting and coating work includes field finishing of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Following categories of work are not included as part of field applied finish work or are included in other sections of these specifications.

1. Shop Priming: Shop priming of ferrous metals items is included under various sections covering structural steel, miscellaneous metal, hollow metal work and similar items.

2. Factory finished materials and equipment, including aluminum doors and frames, aluminum windows, skylights, curtain walls, exterior wall louvers, toilet partitions, toilet accessories, architectural woodwork to extent shop finished, prefinished wood doors, storage shelving, lockers, visual display board trim, prefinished gravel stop, coping and fascia, metal edges, flashing, cyclone fence, acoustic plaster, and similar items.
3. Painting, coating and identification systems for mechanical and electrical work is specified in Plumbing, HVAC and Electrical Contracts Divisions, except as otherwise indicated.
4. Unless otherwise indicated, painting and coatings are not required on surfaces such as walls or ceilings in concealed areas and generally inaccessible areas, furred areas, pipe spaces, duct shafts, lift shafts.
5. Do not paint moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sinkages, sensing devices, motor and fan shafts, unless otherwise indicated.

1.3 REFERENCES

A. SSPC (The Society for Protective Coating) – Steel Structures Painting Manual.

B. EPA (Environmental Protection Agency) Method 24.

C. UL (Underwriters' Laboratories).

D. ASTM E 84 – Test method for Surface Burning Characteristics of Building Materials.

E. OTC (Ozone Transport Commission).

F. Applicable state requirement for VOC (Volatile Organic Compounds).

1.4 DEFINITIONS

A. Sheen: Specular gloss readings in accordance with ASTM D523.

1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, a matte flat finish.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, a high-side sheen flat, velvet-like finish.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, an eggshell finish.
4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, a satin-like finish.
5. Gloss Level 5: 35 to 70 units at 60 degrees, a semi-gloss finish.
6. Gloss Level 6: 70 to 85 units at 60 degrees, a gloss finish.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s descriptive product data for each paint and coating product finish system specified. Include block fillers and primers. Product data shall include the product name and number, product descriptive performance data, (generic classification or binder type), manufacturer’s stock number and date of manufacture, contents by volume for pigment and vehicle constituents, thinning, mixing, application and curing instructions, color name and number, and VOC content and . Submit certification on manufacturer’s letterhead certifying all paint and coating products being provided are in compliance with VOC requirements as required by all applicable local and state regulatory agencies with initial submittal and again at time of application. Submit manufacturer’s printed application instructions and methods, including mixing, surface preparation, compatible primers and topcoats, recommended wet and dry film thickness.

B. Prior to delivery of materials to the site, the Painting subcontractor shall submit for approval, the names and products of the manufacturer to be used. This list shall be on the manufacturer's letterhead and as detailed as the list specified below in Painting and Coating Schedule. The list shall include the specific brands of paints, coatings and finishes that will be provided for each differing surface, plus a statement that the products are suitable for the purposes intended and that they comply with the Specifications. This list shall identify where each product will be used within the project, and on what surface. Submission of manufacturer's materials list and certification of compliance shall receive Architect's approval and/or comment prior to ordering materials.

C. Colors and Samples: Colors shall be selected by the Architect. The Architect will furnish the Painting subcontractor a schedule of colors and locations of various colors.

1. Selected color may or may not be ready mixed colors. Painting subcontractor shall furnish all colors, whether ready mixed, intermixed or special. The Architect will not be restricted in number of colors selected.
2. Submit for Architect's preliminary approval two 6" x 8" stepped brush out samples defining each separate coat. First coat shall be 50% than specified finish coat color. Each succeeding coat shall be 50% lighter than specified finish coat color. Include block fillers and primers of each standard and intermix color selected in a step down fashion on a leneta display card by the approved painting and coating manufacturer and each color shall have manufacturer's identification designation thereon. Provide brush out samples on actual wood surfaces of the appropriate species for transparent finished woods.
3. Identify each sample with color name and number; and product name and number.
4. Label each coat of each Sample.
5. Label each Sample for location and application area.
6. Final acceptance of colors will be from samples applied on the job.

1.6 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has complete painting and coating system applications similar in material and extent to that indicated for this Project with a record of successful in service performance. Applicator for textured systems shall be one who is approved by the textured system manufacturer for proper application of the system.

B. Source limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Material application shall be applied under adequate illumination, evenly spread and smoothly applied, free of runs, sags, holidays, lap marks, air bubbles, and pin holes to assure a smooth finish.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in original unbroken sealed containers with manufacturer's labels intact and in strict accordance with manufacturer's written recommendations. Each container shall be inspected and approved prior to being opened for use. Maintain containers in clean condition, free of foreign materials and residue.

B. Packaging shall bear the manufacturer's label with the following information:

1. Product name and type (description).
2. Batch date.
3. Color number.
4. VOC content.
5. Environmental handling requirements.
6. Surface preparation requirements.

C. Application instructions.

D. Take every precaution against fire. Store materials in tightly covered containers, in a well ventilated locked area with ambient temperatures continuously maintained at not less than 45 deg. F (7 deg. C) and in accordance with manufacturer's written requirements. Keep rags, waste, debris, and materials which may constitute fire hazard in water-filled closed, tightly covered, properly labeled, metal containers for daily removal. If tarpaulins are used, they shall be kept neat and no smoking shall be permitted within the space. Provide and maintain proper Class C hand fire extinguishers in the immediate area and all personnel shall be instructed in their use and informed of their location.

E. Take every precaution against the hazards of fume inhalation. Keep all areas well ventilated at all times. Where natural ventilation is insufficient to provide suitable conditions, provide special fans. If necessary, provide suitable face masks for mechanics.

1.8 PROJECT CONDITIONS

A. Apply paints and coatings only when temperature of surfaces to be painted or coated and surrounding air temperatures is above 50 and below 90 deg F. (10 and 35 deg. C), unless otherwise permitted by and in accordance with manufacturer's printed instructions.

B. Do not apply paint and coatings in snow, rain, fog, mist, or when relative humidity exceeds 70 percent and the surface temperature is at least 5 deg, F (3 deg. C) above the dew point. Prevent wide variation of temperature that might result in condensation on freshly coated surfaces.

C. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 50 deg. F (3 deg. C) for 24 hours before, during and 48 hours after application of finishes.

D. Painting and coating work may be continued during inclement weather if areas and surfaces to be finished are enclosed and heated within temperature and ambient limits specified by the manufacturer during application and drying periods.

E. Take moisture readings of surfaces to be finished on a daily basis with a reliable electronic moisture meter and record moisture readings. Moisture content shall not vary more than the amount allowed by the paint manufacturer's written requirements and recommendations.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional (2) one gallon cans of each color and finish.
2. Label each container with color, type, gloss and room locations in addition to manufacturer's clear and unobstructed label.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S QUALITY

A. Materials shall be the highest quality grade (first line architectural), products of their respective kinds. Primers, stains and finish(es) of each coating system shall be of the same manufacturer.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following, or approved equal.

1. Benjamin Moore (Basis of Design).
2. Sherwin Williams.
3. M.A.B. Paints
4. Or approved equal.

C. Source Limitations: Coatings for each system shall be the product of the same manufacturer to ensure compatibility of systems. Substitutions of equivalent products of other manufacturers may be submitted for approval providing the products submitted are of the same types, have label analyses similar to those specified, meet or exceed the performance criteria, and are suitable for the use intended as approved by the Architect.

D. Use thinning materials only as specified by manufacturer's labeled directions for each type of paint and coating. All coatings shall conform to all Federal, State and Local Regulations including VOC rules and air quality standards in effect at the Project location at the time of application.

2.2 MATERIALS GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint, coating, finishing 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, coating and finishing system, provide products recommended in writing by manufacturers of topcoat for use in paint, coating and finishing system and on substrate indicated.

B. VOC Content of Field-Applied Exterior paints: Provide materials that comply with VOC limits of authorities having jurisdiction.

C. VOC Content of Field-Applied Interior paints, primers, stains, and transparent finish coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints, primers, stains, and transparent finish coatings that are applied in a fabrication or finishing shop:

1. Primers and Undercoaters: VOC content of not more than 100 g/L.
2. Flat Paints, Coatings: VOC content of not more than 50 g/L.
3. Nonflat Paints, Coatings: VOC content of not more than 50 g/L.
4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
5. Clear Wood Finishes, Varnishes: VOC not more than 275 g/L.
6. Clear Wood Finishes, Lacquers: VOC not more than 275 g/L.
7. Floor Coatings: VOC not more than 50 g/L.
8. Waterproofing Sealers: VOC not more than 250 g/L.
9. Sanding Sealers: VOC not more than 275 g/L.
10. All Other Sealers: VOC not more than 200 g/L.
11. Shellacs, Clear: VOC not more than 730 g/L.
12. Shellacs, Pigmented: VOC not more than 550 g/L.
13. Stains: VOC not more than 100 g/L.
14. Dry Fog Coatings: 400 g/L.
15. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
16. Pretreatment Wash Primers: 420 g/L.

D. Colors: As indicated, or if not indicated, as selected by the Architect from manufacturers full range.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Client Agency reserves the right to invoke the following procedure:

1. Client Agency will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.

3. Client Agency may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2.4 PAINTING AND COATING SCHEDULE

A. The following is a general guide for the finish painting required, but does not include every surface or material to be finished or painted. Paint schedule is based on each Manufacturer's first line quality products. Substitution products shall be accompanied by manufacturer's literature establishing evidence of the same; and interior products shall also be in compliance with VOC limits and shall not contain restricted Chemical Components described above.

B. Each of various undercoats of paint other than natural finishes to be a slightly different shade from the preceding coat stepping up to color selected in order to verify number of coats applied.

2.5 EXTERIOR PAINT AND COATING SCHEDULE

A. Exterior Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer. Touch up fabricator primer and spot coat.

1. Semi Gloss Finish/Latex Exposed structural steel, louvers, etc. for average use locations:

a. Prime Coat: 1 coat.

1) Moore: Moorcraft Super Spec Alkyd Metal Primer (Z06).
2) S-W: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
3) MAB: Rustolastic Anti-Corrosive Primer (073 line).
4) PPG: Speedhide Alkyd Metal Primer 6-208.
5) Or approved equal.

b. Finish Coats: 2 coats.

1) Moore: Moorcraft SuperSpec DTM Latex Semi Gloss (Z24).
2) SW: Pro Industrial DTM Acrylic Gloss Coating, B66-650 Series, at 2.5 to 4.0 mils dry, per coat.
3) MAB: Rustolastic Latex Finish Coating (063 line).
4) PPG: Latex Gloss Industrial Enamel 7-282 Series.
5) Or approved equal.

2. Full-Gloss, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer Bollards, Hollow Metal Doors and Frames, etc. for high use locations:

a. Prime Coat: 1 coat.

1) Moorcraft Super Spec Alkyd Metal Primer (Z06).
2) S-W: Kem Bond HS Universal Primer, B50 Series, 2.0 to 5.0 mils dry.
3) MAB: Rustolastic Anti-Corrosive Primer (073 line).
4) PPG: Speedhide Alkyd Metal Primer 6-208.
5) Or approved equal.

b. Finish Coats: 2 coats.

1) Moorcraft Super Spec DTM Alkyd Gloss Enamel Z26.
2) S-W: Pro Industrial Urethane Alkyd, B54-150 Series, at 2.0 to 4.0 mils dry, per coat.
3) MAB: Rustolastic Alkyd Finish Coating (074 line).
4) PPG: Alkyd Gloss Industrial Enamel 7-282 Series.
5) Or approved equal.

B. Galvanized Ferrous Metal: Provide the following finish systems over galvanized ferrous metal:

1. Semigloss, Acrylic Finish: Two finish coats over a primer.

a. Primer: As recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer.
1) Moore: Acrylic Metal Primer #M04.
2) S-W: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
3) MAB: Rustolastic Hydroprime Primer (073-189 line).
4) PPG: Pitt Tech DTM Acrylic Metal Primer 90-712.
5) Or approved equal.

b. 2 Finish Coats: Semigloss, at spreading rate recommended by the manufacturer.

1) Moore: DTM Acrylic SemiGloss #M29.
2) S-W: Pro Industrial DTM Acrylic Semi-Gloss Coating, B66W01151 Series, at 2.5 to 4.0 mils dry, per coat.
3) MAB: Rust-O-Lastic Acrylic DTM (063 line).
4) PPG: Pitt Tech DTM Acrylic Satin Enamel 90-474 Series.
5) Or approved equal.

C. Exterior Application to Exterior Wood surfaces, Gypsum Soffit Board: Low Luster/ Latex:

1. Prime Coat: 1 coat

a. Moore: Fresh Start 100% Acrylic Primer (023).
b. SW: A-100 Exterior Latex Primer, B42W41.
c. MAB: Sea Shore Acrylic Primer (056-958).
d. PPG: Speedhide Exterior Acrylic Primer 6-609.

2. Finish Coats: 2 coats

a. Moore: Moorgard Low Luster Latex House Paint (103).
b. SW: A-100 Exterior Latex Satin A82 Series.

c. MAB: Sea Shore Satin House Paint (060 line).
d. PPG: Speedhide Exterior Satin Acrylic House Paint 6-2045 Series.

D. Exterior Exposed Block: New and previously painted surfaces unless specifically noted otherwise. Low Luster/Latex:

1. Prime Coat: 1 coat.

a. Moore: Super Craft Latex Block Filler #285.
b. S-W: Loxon Block Surfacer A24, at 75 to 125 sq. ft. per gal.
c. PPG: Speedhide Acrylic Block Filler 6-15.
d. Or approved equal.

2. Finish Coats: 2 coats.

a. Moore: MoorGard Latex Low Luster Finish (103).
b. S-W: Loxon XP Waterproofing Coating, A24-1400.
c. PPG: Speedhide Exterior Stain Acrylic House Paint 6-2045 Series.
d. Or approved equal.

2.6 INTERIOR PAINT AND COATING SCHEDULE

A. Interior Ferrous Metal: Provide the following finish systems over ferrous metal: for low abuse areas such as exposed ductwork, decking, trusses, etc.

1. Flat, Latex Finish: Two finish coats over a primer.

a. Primer: Quick-drying, rust-inhibitive, metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer.

1) Moore: IronClad Latex Low Lustre Metal & Wood Enamel, (#363) VOC 380 g/L.
2) S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10 mils wet, 2.0 to 4.0 mils dry.
3) PPG: Pitt-Tech DTM Enamel, Acrylic Primer 90-712, VOC 123 g/L.
4) Or approved equal.

b. Finish Coats: Flat, latex, applied at spreading rate recommended by the manufacturer.

1) Moore: Eco Spec Interior Latex Flat, (#219), VOC 0 g/L.
2) S-W: Promar 200 Zero VOC Interior Latex Flat, B30-2600.
3) PPG: Pure Performance Flat Latex, 9-100 Series, VOC 0 g/L.
4) Or approved equal.

B. Interior Ferrous Metal: Provide the following finish systems over ferrous metal: For use at higher abuse areas such as metal doors and frame, trim, etc.

1. Semigloss, Latex Finish: Two finish coats over a primer.

a. Primer: Quick-drying, rust-inhibitive, metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer.

1) Moore: IronClad Latex Low Lustre Metal & Wood Enamel, (#363) VOC 380 g/L.
2) SW: Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
3) PPG: Pitt-Tech DTM Industrial Enamel, Acrylic Primer 90-712, VOC 123 g/L.
4) Or approved equal.

b. Finish Coats: Semi-Gloss, latex, applied at spreading rate recommended by the manufacturer.

1) Moore:Eco Spec Interior Latex Semi-Gloss Enamel, (#224), VOC 11 g/L.
2) SW: Pro Industrial Pre-Catalyzed Water Based Epoxy, K46-151 Series, at 4.0 mils wet, 1.5 mils dry, per coat.
3) MAB: EnviroPure Latex Semi-Gloss, (047 line), VOC 0g/L.
4) PPG: Pure Performance Semi-Gloss Latex, 9-500 Series, VOC 0 g/L.
5) Or approved equal.

C. Interior Non-Ferrous Metal, New Galvanized and Aluminum:

1. Semigloss, Latex Finish: Two finish coats over a primer.

a. Primer: As recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer.

1) Moore: IronClad Latex Low Lustre Metal & Wood Enamel, (#363) VOC 380 g/L.
2) S-W: Pro Industrial Pro Cryl Universal Acrylic Primer, B66-310.
3) PPG: Pitt-Tech DTM Industrial Enamel, Acrylic Primer 90-712, VOC 123 g/L.
4) Or approved equal.

b. Finish Coats: Semi-Gloss, latex, at spreading rate recommended by the manufacturer.

1) Moore: Eco Spec Interior Latex Semi-Gloss Enamel, (#224), VOC 11 g/L.
2) S-W: Promar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600.
3) PPG: Pure Performance Semi-Gloss Latex, 9-500 Series, VOC 0 g/L.
4) Or approved equal.

D. Interior Exposed Concrete Masonry Units: Classrooms and Media Center unless specifically noted otherwise. (Washable).

1. Semi-Gloss Finish: 2 finish coats over an undercoat and a filled surface at all interior masonry walls unless otherwise noted.

a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer.

1) Moore: Eco Spec Interior Latex Primer Sealer, VOC 0 g/L.
2) SW: Loxon Block Surfacer, A24 Series.
3) PPG: Speedhide Acrylic Block Filler 6-15, VOC 47.5 g/L.
4) Or approved equal.

b. First and Second Coats: (Semi-Gloss), applied at spreading rate recommended by the manufacturer.

1) Moore: Eco Spec Interior Latex Semi-Gloss Enamel, (#224), VOC 11 g/L.
2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300.
3) PPG: Pure Performance Semi-Gloss Latex, 9-500 Series, VOC 0 g/L.
4) Or approved equal.

E. Interior Exposed Concrete Masonry Units: Office areas. Eggshell Finish/Latex:

1. Eggshell Finish: 2 finish coats over an undercoat and a filled surface at all interior masonry walls unless otherwise noted.

a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer.

1) Moore: EcoSpec Interior Latex, Primer Sealer (231), VOC 0 g/L.
2) SW: Loxon Block Surfacer, A24.
3) PPG: Speedhide Acrylic Block Filler 6-15, VOC 47.5 g/L.
4) Or approved equal.

b. First and Second Coats: (Eggshell), applied at spreading rate recommended by the manufacturer.

1) Moore: Eco Spec Interior Latex Eggshell Enamel (223), VOC 1 g/L.
2) SW: ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.
3) PPG: Pure Performance, Interior Eggshell Latex, 9-300 Series, VOC 0 g/L.
4) Or approved equal.

F. Water-Based Dry-Wall System:

1. Flat, Latex Finish: 2 finish coats over a primer (field or shop applied).

a. Application:

1) Stir product thoroughly prior to painting.
2) Apply by airless or conventional spray.
3) Changes in relative humidity will cause significant differences in the distance required for dry fall characteristics. At 50% relative humidity, the product will dry fall at 8 feet. However, at 90% humidity, as much as 15 feet will be necessary for overspray to dry.
4) Do not apply when temperature is below 50 ºF or above 90 ºF.
5) Refer to manufacturer for additional requirements for application.

b. Prime Coat: Shop primer specified in Section where substrate is specified.

1) Surfaces must be clean, dry and free of any rust, oils, or grease.

c. Topcoat: Dry fall, latex.

1) Moore: Alkyd flat, 2 coats Coronado Super Kote 5000 Dry fall (105 line), at 4.0-5.3 mils wet, 1.5-1.9 mils dry.
2) SW: Waterborne Acrylic Dryfall, B42BW3 Flat Black or selected color, at 7.0-11.0 mils wet, 3.0-4.5 mils dry.
3) Or approved equal.

G. Interior Plaster and Drywall: General Use Unless specifically noted otherwise, Eggshell Finish/Latex:

1. Eggshell, Latex Finish: Two finish coats over a primer.

a. Prime Coat: 1 coat New wall surfaces:

1) Moore: EcoSpec Interior Latex, Primer Sealer (231), VOC 0 g/L.
2) SW: ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.
3) MAB: EnviroPure Latex Primer, (037-195), VOC 12 g/L.
4) PPG: Pure Performance, Interior Latex Primer, Series 9-900, VOC 0 g/L.
5) Or approved equal.

b. First and Second Coats: Eggshell, applied at spreading rate recommended by the manufacturer:

1) Moore: EcoSpec Interior Latex Eggshell Enamel (223), VOC 1 g/L.
2) SW: ProMar 200 Zero VOC Latex Eg-Shel, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.
3) MAB: EnviroPure Latex Eggshell Enamel, (045 line), VOC 10 g/L.
4) PPG: Pure Performance, Interior Eggshell Latex, 9-300 Series, VOC 0 g/L.
5) Or approved equal.

H. Interior Drywall: (Subject to moisture) Toilet areas, etc. SemiGloss Latex Finish.

1. Semi-Gloss, Latex Finish: Two finish coats over a primer.

a. Prime Coat: 1 coat New wall surfaces:

1) Moore: Rich Lux Latex Sealer Undercoater (037-154), VOC 70 g/L.
2) SW: ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.
3) MAB: EnviroPure Latex Primer, (037-195), VOC 12 g/L.
4) PPG: Pure Performance, Interior Latex Primer, Series 9-900, VOC 0 g/L.
5) Or approved equal.

b. First and Second Coats: Semi-Gloss, applied at spreading rate recommended by the manufacturer:

1) Moore: EcoSpec Interior Latex Eggshell Enamel (224), VOC 11 g/L.
2) SW: Pro Industrial Waterbased Catalyzed Epoxy, B73-300, at 4.0 mils wet, 1.6 mils dry, per coat.
3) MAB: EnviroPure Latex Semi-Gloss, (047 line), VOC 12 g/L.
4) PPG: Pure Performance, Interior Semi-Gloss Latex, 9-500 Series, VOC 0 g/L.
5) Or approved equal.

I. Interior ceilings – Tectum

1. Flat, Latex Finish: 2 finish coats over a primer (field applied).

J. Mechanical Rooms – Floors
1. Non-slip Epoxy paint.

2.7 STAINING AND TRANSPARENT COATING SCHEDULE

A. Interior Woodwork – Transparent or Stained Finish: Glulam Beams, Wood Trim etc. Low Luster/ polyurethane.

1. Filler Coat:
   a. Moore: Benwood Interior Paste Wood grain filler (238), VOC 250 g/L.
   b. MAB: Filler coat not required.
   c. PPG: per manuf.
   d. Or approved equal.

2. Stain/ Primer Coat: 1 coat
   a. Moore: Interior Wood Finishes Penetrating Stain as needed (234) VOC 550 g/L.
   b. MAB: Old Masters 250 VOC Hi-Solids Penetrating Stain P401-415.
   c. PPG: Olympic Premium Oil Based Wood Stain 44500 series.
   d. Or approved equal.

3. Finish Coats: 2 coats
   a. Moore: Benwood Polyurethane Finish Low Luster (C435), VOC 450g/L.
   b. MAB: Old Masters 350 VOC Hi-Solids Satin Polyurethane 48301.
   c. PPG: Olympic Premium Interior Water Based Polyurethane Clear 42784 series.
   d. Or approved equal.

2.8 MISCELLANEOUS

A. Miscellaneous Items:

1. Provide multiple colors, patterns, borders, fields and designs as indicated, or if not indicated, as selected by the Architect.

2. Items not specifically detailed or mentioned in specifications but necessary to be painted for proper completion of job, shall be painted in accordance with instructions from Architect.

PART 3 - EXECUTION

3.1 INSPECTION

A. Applicator shall examine areas and conditions under which painting work is applied and take moisture readings with a reliable electronic moisture meter in sufficient area in each space and as often as necessary to determine the proper moisture content for application and notify Contractor in writing of conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the Applicator and in accordance with paint manufacturer's written requirements for surface preparation. Starting of painting work will be construed as Applicator's acceptance of such faces and conditions within any particular area.

B. Substrate Conditions:

1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

a. Concrete: 12 percent.
b. Masonry (Clay and CMU): 12 percent.
c. Wood: 15 percent.
d. Gypsum Board: 12 percent.
e. Plaster: 12 percent.

2. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

3. Plaster Substrates: Verify that plaster is fully cured.

4. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.

C. Proceed with coating application only after unsatisfactory conditions have been corrected; application of coating indicates acceptance of surfaces and conditions

3.2 SURFACE PREPARATION

A. General: Perform preparation and cleaning procedures in accordance with paint manufacturer's written instructions and recommendations and as herein specified, for each particular substrate condition.

B. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Contractor shall prepare all surfaces, walls, ceilings, metal frames, etc., which are to be painted, including but not limited to, scraping, sanding, spackling, patching etc. as necessary to remove loose particles, paint, mildew, greasy residue, splatters, burrs, graffiti, surface decals, surface applied texture materials, mastic, glue, etc. Repoint and/or spackle holes, voids, defects, etc. to form a smooth level surface. Remove nails, screws, anchors and the like. Sand existing metal frames, etc. to smooth out edges of various paint layers.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Clean surfaces to be painted before applying paint or surface treatments. Remove dirt, oil and grease using an oil and grease emulsifier such as Moore’s M83, or approved equal in accordance with SSPC-SPI Method B2 prior to mechanical cleaning. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly painted surfaces.

E. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

1. Concrete Floors: Remove oil, dust, grease, dirt, and other foreign materials. Comply with SSPC-SP-13/NACE 6 or ICRI 03732.

F. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

G. Ferrous Metals: Clean ferrous surfaces, which are not galvanized or shop-coated of oil, grease, dirt loose mill scale and other foreign substances by solvent or mechanical cleaning (SSPC – SP-1).

H. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal.”

I. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

J. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

K. Aluminum Substrates: Remove loose surface oxidation.

L. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

M. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing and application of paint in a clean condition, free of foreign materials and residue.

C. Stir materials before application to produce a mixture of uniform density, and stir as required during application. Do not stir surface film into material. Remove film and if necessary, strain material before using.

3.4 APPLICATION

A. General: Apply paint in accordance with manufacturer's written instructions and recommendations. Use applicators and techniques best suited for substrate and type of material being applied. Apply according to recommended dry film thickness and recommended square foot per gallon.

B. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers. Do not proceed without written confirmation from the topcoat manufacturer sent to Architect. Bare areas are to be spot primed

D. Apply materials under adequate illumination, evenly spread and smoothly applied, free of runs, sags, holidays, lap marks, air bubbles, and pin holes to assure a smooth finish.

E. Apply additional coats when undercoat, stains or other conditions show through final paint coat, until paint film is of uniform finish, color and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces. Deep color base primers are to be used under deep finish colors to achieve proper color appearance.

F. Paint surfaces behind moveable equipment and furniture same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only before final installation of equipment.

G. Paint back sides of access panels, and removable or hinged covers to match exposed surfaces.

H. Sand lightly all abrasions and damaged spots, between each succeeding enamel, varnish coat, textured paint coat, and degloss previous painted surfaces if necessary. Spot prime water soluble stains. Reprime prior to applying finish coats as required.

I. Scheduling Painting: Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

J. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of the under coat.

K. Minimum Coating Thickness: Apply materials at not less than manufacturer's recommended spreading rate, to establish a total dry film thickness as indicated or, if not indicated, as recommended by coating manufacturer.

L. Prime Coats: Apply prime coat of material which is required to be painted or finished, and which has not been prime coated by others. Prime coats shall be of the same manufacturer as the top coat.

M. Recoat primed and sealed surfaces where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

N. Pigmented (Opaque) Finished: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable. Cut in sharp lines and color breaks.

O. Provide satin finish or semi-gloss for final coats as indicated in the painting schedule, unless otherwise indicated.

P. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in occupied spaces:

    a. Equipment, including panelboards.
    b. Uninsulated metal piping.
    c. Uninsulated plastic piping.
    d. Pipe hangers and supports.
    e. Metal conduit.
    f. Plastic conduit.
    g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
    h. Other items as directed by Architect.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

Q. Guarantee: Manufacturer shall warrant material to conform to specification and be free of manufacturing defects for a period of one year. Applicator will guarantee that its installation of materials conforms to manufacturer's recommendations shall further guarantee its workmanship connected with the installation for a period of one year from the date of installation.

R. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not in compliance with specified requirements.

S. Touch-up work: Touch-up work shall be the responsibility of the Painting Subcontractor.

3.5 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness, confirming that paint has been installed to meet paint manufacturer’s requirements.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.6 CLEAN-UP AND PROTECTION

A. Clean-up: During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass, plumbing fixtures, etc., and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Protection: Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and repainting as acceptable to Architect.

D. Provide ***'Wet Paint'*** signs as required to protect newly painted finishes. Remove temporary protective wrappings provided for protection of their work, after completion of painting operations.

E. At completion of work of other trades, Painting Subcontractor shall touch-up and restore all damaged or defaced painted surfaces.

END OF SECTION 099000

SECTION 101423 - ROOM-IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes room-identification signs for the offices that are directly attached to the building.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For room-identification 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 at least half size.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allen Industries Architectural Signage.
b. Seton Identification Products.
c. Signs & Decals, Corp.
d. Vista System.

2. Laminated-Sheet Sign: Photopolymer or Sandblasted polymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.

a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
b. Surface-Applied Graphics: Applied vinyl film.
c. Subsurface Graphics: Reverse halftone or dot-screen image.
d. Color(s): As selected by Architect from manufacturer's full range.

3. Sign-Panel Perimeter: Finish edges smooth.

a. Edge Condition: Square cut.
b. Corner Condition in Elevation: Square.

4. Mounting: Manufacturer's standard method for substrates indicated.

2.3 SIGN MATERIALS

A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

B. Vinyl Film: UV-resistant vinyl film with pressure-sensitive, permanent adhesive; die cut to form characters or images as indicated on Drawings.

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:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened sign 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. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

C. 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. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
3. 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.

B. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.

C. Subsurface-Etched Graphics: Reverse etch back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

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.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

   a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
   b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. 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. 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.
4. 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 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. Removing above- and below-grade site improvements.
2. Disconnecting, capping or sealing, and removing site utilities.
3. Temporary erosion and sedimentation control.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL CLIENT AGENCYSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Client Agency's property, cleared materials shall become Contractor's property and shall be removed from Project site.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Client Agency and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed trafficways if required by Client Agency or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Client Agency's premises where indicated.

C. Utility Locator Service: Notify One Call for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Client Agency.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

B. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place.

C. Excavate for and remove underground utilities indicated to be removed.

3.4 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.5 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Client Agency's property.

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. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for walks, pavements and plants.
3. Excavating and backfilling for buildings and structures.
4. Subbase course for concrete walks.
5. Subbase course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for granular course if placed over vapor retarder and beneath the slab-on-grade.
2. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.3 UNIT PRICES

A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.5 PREINSTALLATION MEETINGS

1.6 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Geotextiles.
2. Controlled low-strength material, including design mixture.
3. Geofoam.
4. Warning tapes.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

1.8 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Client Agency and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Client Agency or authorities having jurisdiction.

B. Utility Locator Service: Notify “One Call” for area where Project is located before beginning earth-moving operations.

C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 311000 "Site Clearing" are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 2 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and zero to 5 percent passing a No. 8 (2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and zero to 5 percent passing a No. 4 (4.75-mm) sieve.

J. Sand: ASTM C 33/C 33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

L. Produce conventional-weight, controlled low-strength material with 80-psi (550-kPa) compressive strength when tested according to ASTM C 495/C 495M.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. 24 inches (600 mm) outside of concrete forms other than at footings.
b. 12 inches (300 mm) outside of concrete forms at footings.
c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
e. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: As indicated.

3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete."

D. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in [Section 033000 "Cast-in-Place Concrete."

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

2. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.

G. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

H. Warning Tape: Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698.

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course to required crown elevations and cross-slope grades.
4. Place subbase course 6 inches (150 mm) or less in compacted thickness in a single layer.
5. Place subbase course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.20 FIELD QUALITY CONTROL

A. Testing Agency: Client Agency will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Client Agency's property.

B. Transport surplus satisfactory soil to designated storage areas on Client Agency's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Client Agency's property.

END OF SECTION 312000

SECTION 323113 - CHAIN LINK FENCES AND GATES

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. Chain-link fence and access gate at storage area beneath garage ramp at ground floor.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

1. Fence and gate posts, rails, and fittings.
2. Chain-link fabric, reinforcements, and attachments.
3. Gates and hardware.

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

1.4 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to structure. Verify dimensions by field measurements.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

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

a. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: As indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.148 inch (3.76 mm).

a. Mesh Size: 2 inches (50 mm).
b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) with zinc coating applied before weaving.
c. Coat selvage ends of fabric that is metallic coated after the weaving process with manufacturer's standard clear protective coating.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: As indicated on Drawings.

2. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40

a. Line Post: 2.375 inches (60 mm) in diameter.
b. End, Corner and Pull Post: 2.875 inches (73 mm) in diameter.

3. Horizontal Framework Members: Intermediate, top and bottom rails complying with ASTM F 1043.

a. Top Rail: 1.66 inches (42 mm) in diameter.

4. Brace Rails: Comply with ASTM F 1043.
5. Metallic Coating for Steel Framing:

a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
b. Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
c. External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.

d. Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
e. Coatings: Any coating above.

2.3 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single swing gate types.

1. Gate Leaf Width: 36 inches (914 mm).
2. Gate Fabric Height: 72 inches (1830 mm).

B. Pipe and Tubing:

1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
2. Gate Posts: Round tubular steel
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded or assembled with corner fittings.

D. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

2.4 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.

1. Provide line post caps with loop to receive tension wire or top rail.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:

1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.

E. Tension and Brace Bands: Pressed steel.

F. Tension Bars: Steel, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:

a. Hot-Dip Galvanized Steel: 0.148-inch- (3.76-mm-) diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for conditions affecting performance of the Work.

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

3.2 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

3.3 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts with mechanical anchors into concrete slab.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with mechanical devices.

C. Line Posts: Space line posts uniformly at 96 inches (2440 mm) o.c.

D. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

E. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

F. Intermediate and Bottom Rails: Install and secure to posts with fittings.

G. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch (25.4 mm) between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

H. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.

I. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.

J. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

3.4 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary.

3.5 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 170010

REMOVAL OF ASBESTOS CONTAINING MATERIALS

PART 1 - GENERAL

1.01 STIPULATIONS

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

B. The procedures specified herein are guidelines for minimum performance. The Contractor is responsible for his own methods of operations and conformance to regulatory codes, rules and guidelines. The Contractor is required to obtain all permits, licenses and approvals to perform the work, including any rights to use patented systems.

1.02 SCOPE OF WORK

A. The scope of work for this project covers the supplying of all labor, tools, materials, equipment, services and appurtenances to accomplish the work specified and indicated on the contract drawing. The work shall be performed to the complete satisfaction of the Department in accordance with the current EPA and OSHA regulations, State Labor and Industry and Department of Environment Protection regulations and any other applicable State and Local Government regulations.

B. Contractor shall submit an Action Plan which describes specifically how abatement work is to be completed for each abatement phase. At a minimum the work Plan shall address work area preparation, work practices, decon location, estimated completion dates, respiratory protection, and disposal. Approval of the Action Plan must be obtained through the Professional prior to the start of work. Procedures outlined in the Action Plan must be followed throughout the abatement phase. Any changes in Action Plan must obtain prior approval from Professional.

1.03 CONTROL OF WORK

A. All work which does not conform to the requirements of the contract, plans and specifications will be considered unacceptable.

B. Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be corrected immediately and replaced in an acceptable manner.

C. All bidders should inspect job site prior to bidding to determine job conditions.

D. If the Department finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or material shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

E. The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the plans, contract and specifications. The term shall not be construed as waiving the Department's right to insist on strict compliance with the requirements of the contract, plans and specifications during the Contractor's prosecution of the work, when in the Department's opinion and judgment such compliance is essential to provide an acceptable finished work.

1.04 QUALITY ASSURANCE

A. Consultant:

1) The Professional shall contract for a Quality Assurance Consultant Project Monitor hereafter referred to as ‘Consulting Firm’ which specializes in performing air sampling, project monitoring and inspections on asbestos abatement projects. The testing laboratory shall as a minimum be accredited by the NIOSH PAT Program (Proficiency Analytical Testing) for PCM asbestos air analysis, and NVLAP for asbestos bulk analysis.

2) The Consulting Firm will be responsible for certifying the project was completed in accordance with all federal, state, and local asbestos standards and regulations.

3) The Consulting Firm and Asbestos Abatement Contractor must complete the Certification of Visual Inspection form found at the end of this section for each work area completed.

4) The Consulting Firm shall review the Contractors Action Plan which describes specifically how work is to be completed for each abatement phase. Approval of the Action Plan must be obtained through the Professional prior to the start of work.

B. Contractor Experience:

1) The Asbestos Abatement Contractor shall have a minimum of three (3) years experience in the asbestos abatement business. He shall have successfully completed three (3) projects of similar or larger size and dollar value to this project and shall not have defaulted on an asbestos abatement project within the last three (3) years. The Contractor shall be certified by Pennsylvania Department of Labor and Industry.

C. Worker Certification:

1) The Contractor shall furnish proof that his employees have had instruction on the dangers of asbestos exposure, on respirator use, decontamination and current OSHA and EPA regulations.
2) Documentation of workers medical exams, consist of x-rays and pulmonary function shall be submitted and as may be required by current OSHA and EPA regulations and any applicable State and Local Government regulations.
3) There must be on site at all times, an EPA Certified Asbestos Abatement Supervisor. The Asbestos Abatement Supervisor shall have successfully completed a 5-day EPA Certified Practices and Procedures Course as per 40 CFR, Part 763, Subpart E, Appendix C-EPA Model Accreditation Plan (must provide a copy of certificate from EPA approved course). All asbestos workers shall have successfully completed a 4-day EPA Certified Practices and Procedures Course as per 40 CFR, Part 763, Subpart E, Appendix C-EPA Model Accreditation Plan. The Contractor must provide copies of certificates from Pennsylvania Department of Labor and Industry for all workers, and supervisors as required by regulation.
4) When required by the Pennsylvania Department of Labor and Industry (PDL&I) the Contractor, Abatement Supervisor, and Abatement Workers shall be licensed by PDL&I. Each worker/supervisor shall have a current photo identification issued by PDL&I available on request by the Department when required.

1.05 POSTING OF REGULATIONS

A. The Contractor will have at all times in his possession at his office one (1) copy and in view at the job site one (1) copy, current OSHA Regulations 29 CFR 1926.1101, Asbestos and current Environmental Protection Agency 40 CFR Part 61, Subpart M: National Emission Standard for Hazardous Air Pollutants as related to asbestos stripping, emissions, notification, work practices and disposal of asbestos waste.

1.06 REGULATORY SUBMITTALS (CONTRACTOR'S RESPONSIBILITY)

The Contractor is required to notify the building occupants and the following agencies in writing ten (10) days prior to starting work for notification and instructions concerning proper disposal of asbestos waste material.

1) United States Environmental Protection Agency - Region III
Asbestos - NESHAP Coordinator (3WC32)
1650 Arch Street
Philadelphia, PA 19103-2029

2) Asbestos Notification
DEP Bureau of Air Quality
PO Box 8468
Harrisburg, PA 17105-8468

3) Pennsylvania Department of Labor and Industry
Bureau of Occupational and Industrial Safety
Seventh & Forster Streets - Room 1623
Harrisburg, Pennsylvania 17120

4) EPA, DEP approved asbestos landfill proposed to be used by the Contractor for RACM. Submit completed WSR for RACM at projects end (see 3.07, F).

1.07 AIR TESTING AND MONITORING

A. Air sampling of the work areas and surrounding environment will be conducted during the performance of this contract by the Consulting Firm so as to ensure abatement procedures are in compliance with all codes, regulations, ordinances and this specification.

B. The Contractor shall fully cooperate with the Consulting Firm and all others responsible for testing and inspecting the work.

C. Air testing and analyses shall be in accordance with current EPA and requirements of Section 29 CFR 1926.1101 of the current OSHA Regulations, as a minimum.
Analysis shall be performed by Phase Contrast Microscopy per NIOSH 7400 Method and/or Transmission Electron Microscopy (TEM) per EPA Level II (AHERA) analytical procedures.

D. Air tests taken prior to start of work (background) and at completion (pre-clearance) will be analyzed by PCM-Phase Contrast Microscopy. Final (clearance) testing shall be by TEM-Transmission Electron Microscopy.

E. The Consulting Firm shall give verbal notification to the Department of the results of each test within twenty-four (24) hours of the time the samples were delivered to the laboratory. The Consulting Firm shall confirm the results in writing within three (3) days thereafter. A microscope on site for PCM analyses is acceptable to facilitate a faster turn-around time.

F. Prompt reports are necessary so that, if required, modifications to work methods and/or practices may be implemented as soon as possible.

G. Representatives of the Consulting Firm shall have access to the work area at all times. The Contractor shall provide facilities for such access in order that the Consulting Firm may properly perform its function.

H. Sampling equipment and personnel will be provided by the Consulting Firm.

I. Air sampling shall be performed in each work area prior to commencement of the work at that location. The highest fiber count reading during pre-clearance clean-up monitoring shall be lower than the background readings established by pre-job monitoring or 0.01 f/cc, whichever is lower. When the criteria is met, perform final clearance testing by Transmission Electron Microscopy (TEM) using EPA Level II methodology. Clearance criteria is 70 s/mm^2 for fibers greater than .5 microns in length with an aspect ratio 5:1.

J. Air samples shall be taken in accordance with, but not necessarily limited to, the following schedule:

AREA	WHEN	NUMBER	MINIMUM VOLUME (liters)	FLOW RATE (liters/min.)
Work Area(PCM)	Prior to job start	2	1500	2-10
Work Area(PCM)	During area isolation	Daily[1]	480-960	1-2
Work Area-Inside (PCM)	During abatement work	Daily[1]	480-960	1-2
Work area Exterior (PCM)[2]	During abatement work	Daily[1]	1000	2-10
Work Area(PCM)[4]	Upon work(preclearance)completion	2(minimum)	1500	2-10
Work Area (TEM)[4]	At completion (final)	1[3]	1200	2-10

SCHEDULE NOTES:

1 Consecutive daily air samples will be collected during abatement to yield a minimum of eight (8) hours of sampling time for each active work area.

2 Exterior work area(s) samples shall be collected daily at decon clean room entrance, load out exit, discharge of HEPA exhaust units, and area(s) adjacent to work area(s) that are occupied or will be re-occupied.

3 One sample collected and analyzed per work area; archive remaining filter for one year.

4. Aggressive air sampling must be conducted when work area is prepared as a negative pressure enclosure.

K. Work area clearance testing shall be completed before work site protective barriers are removed.

L. The Contractor is responsible for performing the thirty (30) minute excursion air sampling per OSHA regulations.

M. The Contractor is responsible for performing 8 hour TWA personal air samples in the employees breathing zone per OSHA regulations.

1.08 AIR FILTERING

A. An approved negative pressure machine may be used in the active work area using HEPA equipped air movement units.

B. Air may be drawn from clean areas through the decontamination and active work areas, HEPA filtered and exhausted through air movement units to the containment exterior. Replace filters in accordance with manufacturer's instructions and to meet the needs of this specification.

C. Air movement should be sufficient quantity to ensure a minimum of four (4) air changes per hour.

Example: Active work area = 50' x 50' x 20' H = 50,000 cu. ft.

For four air changes per hour = 4 AC/HR x 50,000 CF/AC = 200,000 cu.ft./hr.

In cubic feet per minute = 200,000 CF/HR: 60 min/hr = 3,333 cu. ft./minute

This active work area would require a combination of air movement/HEPA units, i.e., 2,500 CFM and 1,500 CFM

D. The exhaust system must be sufficient to maintain a minimum pressure differential of -0.02 inches of water relative to unsealed, adjacent area. Provide continuous, twenty-four (24) hours per day monitoring of the pressure differential with an automatic recording instrument.

E. The exhaust system(s) will run twenty-four (24) hours/day until final clearance is obtained and will be maintained in accordance with ANSI Z9.2 and the manufacturer’s directions.

F. To ensure continuous operation, the Contractor shall have a spare negative exhaust unit available.

1.09 ALTERNATIVE AIR FILTERING METHODS

A. Other approved air filtering methods may be utilized at the Contractor's discretion, with the stipulation that designated regulatory agencies provide documented approval to the Department. It shall be the responsibility of the Contractor to submit all documentation required to the appropriate regulatory agency for their review and approval.

1.10 PLACEMENT OF WARNING SIGNS AND LABELS

A. The Contractor shall furnish and place warning signs at all approaches to asbestos control areas containing concentrations of airborne asbestos fibers. Locate warning signs at such a distance that personnel may read the warning sign and take the necessary protective action required before entering the area. Warning signs shall be in place for the duration of the work. The Contractor shall furnish and attach caution labels to all disposal containers holding asbestos materials, scrap waste, debris and other products contaminated with asbestos.

B. Warning Signs: Provide warning signs conforming to 29 CFR 1926.1101 with the following legend:

DANGER
ASBESTOS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
AUTHORIZED PERSONNEL ONLY
WEAR RESPIRATORY PROTECTION AND
PROTECTIVE CLOTHING IN THIS AREA

C. Caution Labels: Attach label to the outside of all disposal bags and containers which hold asbestos contaminated materials and are to be removed from the site. Caution labels shall be printed in letters of sufficient size and contrast so as to be readily visible and legible and shall display the following legend:

DANGER
CONTAINS ASBESTOS
FIBERS MAY CAUSE
CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATH DUST
AVOID CREATING DUST

D. Identification Labels: Attach label to the outside of all disposal bags and containers which hold asbestos contaminated materials and are to be transported off facility site. Identification labels shall display the following legend:

Waste Generator Name: _____Fill Out_____

Generator Location: _____Fill Out_____

E. Transportation marking shall conform to 49 CFR 171 and 172 and shall be provided on all containers with more than one pound of friable asbestos. Transportation marking shall display the following legend:

(NA2212, Asbestos, 9, PGIII, RQ)

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. The list of required materials will include, but is not necessarily limited to the following:

1) Respirators: Provide respiratory protection in accordance with OSHA Regulation 29 CFR 1926.1101 and appendices ANSI Z88.2-1980. Respiratory protection use is mandatory regardless of negative exposure assessments. There shall be NO EXCEPTION to this requirement. As minimum protection, negative pressure air purifying respirators shall be worn. Contractor shall select the appropriate respirator based on an initial exposure assessment or exposure monitoring results. No employee or visitor shall enter any area without this protection until clearance has been obtained. Employees or visitors shall wear a respirator. Respirators shall be NIOSH approved. Ensure proper filters are worn using a HEPA as a minimum.

2) Protective Clothing:

a) Disposable Clothing – such as "Tyvek" by DuPont. Clothing shall consist of coverall, head cover and foot cover. Gloves will be worn for hand cover as needed.

3) Wetting Agents - The asbestos material will be sprayed with water containing an additive to enhance penetration. The additive, or wetting agent, will be polyoxyethylene at a concentration of one (1) ounce per five (5) gallons of water or as otherwise specified by manufacturer. A fine spray of this solution must be applied to prevent fiber disturbance preceding the removal of the asbestos material. The asbestos will be sufficiently saturated to prevent emission of airborne fibers in excess of the exposure limits prescribed in the current OSHA standards referenced in these specifications. DRY
REMOVAL WILL NOT BE ALLOWED EXCEPT WITH WRITTEN APPROVAL FROM EPA or BECAUSE OF FREEZING WORK AREA TEMPERATURES.

4) Polyethylene sheeting: Six (6) mils, for protection of floors, walls, doors, windows, fixed equipment, HVAC supply and return openings, and critical barriers.

5) Polyethylene bags (with warning labels) six (6) mils minimum for disposal. All asbestos that is removed shall be double bagged.

6) Tape: High quality vinyl or fabric duct tape. Paper masking tape will not be permitted.

7) Negative Pressure Filtration Equipment: Air movement and filtering equipment equipped with HEPA filters rated at 99.97% removal down to 0.3 microns, and of sufficient capacity to provide a minimum of four (4) air changes per hour for each active work area.

8) Airless Spray Equipment: Electric airless spray equipment for saturating and mist fiber control. Low pressure (500 psi) equipment must be available onsite and utilized as required.

9) Vacuum: HEPA rated for surface cleaning and house-keeping. Hand operated and power tools such as, but not limited to, saws, corers, abrasive wheels and drills should be provided with local exhaust ventilation systems with HEPA filters.

10) Hand Tools: Brooms, plastic shovels, scrapers, brushes, etc., in sufficient quantity to ensure the appropriate level of housekeeping.

11) Water Filtration System: Shower and contaminated water filtration system.

12) GFI Equipment: All electrical connections in the work area must be through "ground fault" protected outlets/circuits.

13) Penetrating Encapsulant: Penetrating encapsulants to be used on this project are International Cellulose Corporation SK-13 Asbestos Encapsulant, International Protective Coatings Corporation Serpiflex Shield, Fiberlock Technology ABC Asbestos Binding Compound Concentrate, and others listed as acceptable in the Environmental Protection Agency - Battelle Laboratory Encapsulant Study, or approved equal.

14) Bridging Encapsulant: Bridging encapsulants to be used on this project are
American Coatings Corporation Cable Coating 2B, Decadex Laboratories Firecheck, Fiberlock Technology ABC Asbestos Binding Compound Concentrate, or approved equal.

B. The Contractor will have at all times in his possession at the job site Material Safety Data Sheets (MSDS) for wetting agents, encapsulants, solvents, strippers, and any other potentially hazardous materials.

2.02 PERSONNEL PROTECTIONS

A. Personnel protection is required for laborers, mechanics, supervisors and visitors at the work site during the set-up and abatement operations.

B. Each worker shall be supplied with a minimum of two (2) complete protective work clothes and respirator filter changes per day for the complete duration of the project. Hard hats should be available as appropriate which meet ANSI Z-89.1 standards. Safety toe footwear is to be worn underneath the disposable shoe covers and must meet the requirements and specifications in ANSI Z-41.1. Eye wear and face protection must meet the standards and specifications of ANSI Z-87.1.

C. In addition to sets of protective work clothes for workers, the Contractor shall have on hand two (2) additional sets of disposable work clothes, per day and respirators for personnel who are authorized to inspect the work site. Hard hats should be available as appropriate which meet ANSI Z-41.1. Eye wear and face protection must meet the standards and specifications of ANSI Z-87.1.

D. Respirators approved for asbestos use and protective work clothes will be worn by laborers and mechanics as a minimum during set-up operations (plastic draping, light-fixture dropping or removal, etc.).

E. Appropriate respirators will be worn by all personnel in the active work area.

F. Upon leaving the active work area, filters will be discarded, cartridges removed and respirators cleaned in disinfectant solution and clean water rinse.

G. Clean respirators will be stored in plastic bags when not in use.

H. Respirators will be inspected daily for broken, missing, or deteriorated parts.

PART 3 - EXECUTION

3.01 AREA PREPARATION

A. Movable furniture, blinds, and equipment will be removed from area of work by the Client Agency.

B. Heating and ventilating system servicing the areas of work must be shut down prior to starting any work. Notify the Institution prior to starting any work in order that they may arrange to have the heating and ventilating system shut down.

C. The Contractor shall isolate the work area for the duration of the work by installing critical barriers completely sealing off all openings in the work area, including, but not limited to, heating, ventilation ducts, doorways, corridors, windows, roof ventilator openings, and wall vents, with plastic sheeting taped securely in place with six (6) mils plastic sheeting.

D. The Contractor shall build decontamination chamber(s) to be connected to each active work area for entrance to or exit from the active work area. When required a separate material load out unit shall be constructed.

E. All floor and wall surfaces in the work areas shall be covered with plastic sheeting taped securely in place to protect them from water damage and asbestos contamination.

F. The Contractor shall cover all fixtures, fixed demountable partitions, lighting, fixed items and equipment in the work area with plastic sheeting taped securely in place.

G. Duct tape, staples, wood strips and other methods will be used appropriately to attach vertical plastic barriers to walls and to floors. All edges of plastic material shall overlap the adjoining sheet a minimum of twelve inches. All joints (vertical and horizontal) to be continuously sealed with duct tape.

H. Upon completion of area isolation, the Contractor shall remove, where practical, all detachable electrical heating and ventilation equipment, wipe and vacuum, clean and remove from active work area.

3.02 DECONTAMINATION UNIT (USAGE AND ACTIVITIES)

A. Outside room (clean room). In this room the worker leaves all street clothes and dresses in clean working clothes (usually disposable coveralls). Respiratory protection equipment is also stored in this area. No asbestos

contaminated items should enter this room. Workers enter this room either from outside the structure dressed in street clothes, or naked from the showers, after showering.

B. Shower Room: This is a separate room used for transit by cleanly dressed workers entering the job from the outside room or by workers headed for the showers after undressing in the equipment room.

C. Equipment Room (contaminated area): Work equipment, footwear, additional contaminated work clothing are left here. This is a change and transit area for workers.

D. Decontamination chambers require temporary services. Verify during bidding period the availability for temporary hook up. Mobilization, hook-up and demobilization, disconnection costs will be the responsibility of the Contractor. Installation of temporary services during demolition shall be per current EPA and OSHA regulations.

E. Work Area: The work area should be separated by polyethylene barriers from the equipment room. If the airborne asbestos level in the work area is expected to be high, as in dry removal an additional intermediate cleaning space may be added between the equipment room and the work area. Isolation of the work areas, as required, is necessary to prevent contamination and fiber dispersal to other areas of the building during work and clean-up operation. Air movement will flow uninterrupted from outside the work area through the change and equipment rooms and into the active work area. It is then HEPA filtered and exhausted to the building exterior.

3.03 WORK AREA ENTRANCE/EXIT

A. All workers involved in the removal of asbestos will utilize the following procedure for work area entrance and exit.

B. The worker enters the outside room and removes clothing, puts on clean coveralls, gloves and respirator. Protective clothing sleeves will be taped to gloves and protective clothing legs will be taped to foot covers. The neck collar, zipper seam, wrists and ankles of protective clothing will be taped closed.

C. Worker proceeds via shower room to equipment room. Any additional clothing and equipment left in equipment room and required by worker is put on. This includes additional warm garments workers usually provide themselves when the work area is too cold for coveralls only. These must be treated as contaminated clothing and left in the decontamination area.

D. Worker proceeds to work area.

E. Before leaving the work area, the worker should remove all gross contamination and debris from the protective clothing, by vacuuming down the clothes with a vacuum cleaner with a HEPA filter. In practice, this is carried out by one worker assisting another.

F. The worker proceeds to equipment room and removes all clothing except respiratory protection equipment. Extra work clothing may be stored in contaminated end of the area.

G. Disposable protective clothing is placed in a bag for disposal. The worker then proceeds into the shower room. Respiratory protection equipment should only be removed after wetting in shower to prevent inhalation of fibers. Ensure that employees shower every time upon exiting the work area and before entering the clean room.

H. After showering, the worker moves to the clean room and dresses in either new protective clothes for another entry, or street clothes if leaving. Respirator filters are sealed with tape or thrown away if spent, and respirator body is thoroughly cleaned and brought to the clean room.

I. Workers shall not eat, drink, smoke, chew gum, or chew tobacco in the work area. To eat, drink or smoke, workers shall exit the work area following the decontamination procedure outlined above.

J. All footwear shall be left inside work area until completion of the job, then cleaned or discarded.

3.04 METHOD OF REMOVAL

A. Remove the existing windows in the indicated areas. All asbestos containing caulking must be removed from the remaining masonry.

B. Remove existing asbestos containing plaster ceiling components including the metal lath, the existing steel ceiling structure, and ties in the indicated areas.

C. Remove and dispose of all asbestos-containing materials (ACM) in accordance with the methods and procedures outlined in the United States Department of Labor, Occupational Safety and Health Administration (OSHA) Asbestos Regulations, Codes of Federal Regulations Title 29, Part 1926, Section 1926.1101.

D. Dry removal will not be allowed except when wet removal will create a safety hazard. Dry removal process will require written authorization by EPA and the Department except when work area has freezing conditions.

E. Work of this section shall be performed in the following manner:

1) Eliminate air flow into containment area by isolating all supply and return air ducts from mechanical system. Turn off electrical power.

2) Install six (6) mil polyethylene critical barriers over all doors, wall openings, ceiling openings, electrical outlets, etc. Secure with duct tape on all sides.

3) Six (6) mil polyethylene protecting ceiling surface from wall to wall.

4) Six (6) mil polyethylene protecting wall surface from floor to ceiling.

5) Isolation barriers separating occupied areas and work areas shall be framed and covered with 1/2-inch plywood and two (2) layers of six (6) mil polyethylene.

6) Duct HEPA filter unit through door. Locate unit to prevent dead air pockets.

7) Install triple air curtain, six (6) mil polyethylene (typical), over door opening into decontamination unit or load out unit.

3.05 HOUSEKEEPING

A. Throughout the work period, the Contractor shall maintain the building and site in a standard of cleanliness as specified throughout these specifications.

B. Contaminated disposable clothing, respirator filters and other debris will be bagged, properly labeled and sealed at the end of each work day.

C. All asbestos generated by either removal, encapsulation or repair will be bagged, properly labeled, and sealed at the end of each work day.

D. Respirators will be thoroughly cleaned at the end of each work day and stored for the next day's use.

E. Retain all stored items in an orderly arrangement allowing maximum access, not impeding traffic, and providing the required protection of materials.

F. Do not allow the accumulation of scrap, debris, waste material, and other items not required for completion of this work.

G. At least weekly, and more often if necessary, completely remove all scrap, debris and waste material from the job site.

H. Unless otherwise noted or directed, materials resulting from demolition operations shall be the property of the Contractor, shall not be used in the work and shall be promptly removed from the site.

I. Daily and more often if necessary, inspect the work areas and adjoining spaces, and pick up all scrap, debris and waste material. Remove all such items to the place designated for their storage.

J. Provide adequate storage for all items awaiting removal from the job site, observing all requirements for fire protection and protection of the ecology.

K. Maintain the site in a neat and orderly condition at all times.

L. Compressed air is not to be used for cleaning purposes.

3.06 FINAL DECONTAMINATION OF WORK AREA

A. Following careful double bagging of all removed asbestos material by the Contractor, he shall label bags as required.

B. Bags shall be wiped with clean damp cloths prior to transportation to approved disposal site.

C. With critical barriers in place, sheet plastic on walls, floors, and ceiling, the negative pressure system operating, the Contract shall carry out the first cleaning. If there are two layers of wall, floor, and ceiling plastic, clean outer layer as described below and remove carefully. With one layer of wall, floor, and ceiling plastic in place, use damp cleaning cloth to wipe surfaces of plastic. Use each surface of a cleaning cloth one time and then dispose of as contaminated waste.

D. Continue this cleaning until there is no visible debris from removed material or residue on plastic sheeting. This first cleaning shall extend to include the Equipment Room (Dirty Room) in the decontamination unit.

E. Pressure washing techniques of any kind are strictly prohibited.

F. Pre-Encapsulation Inspection of substrate is performed by Consulting Firm to ensure removal and cleaning of the substrate is adequate. The Contractor may accompany this inspection. If during the inspection, the substrate or plastic sheeting isn't cleaned to the satisfaction of the Consulting Firm, additional re-cleaning will be required to meet the satisfaction of the Consulting Firm.

G. Encapsulate substrate and all remaining plastic sheeting within the work area. A colored encapsulant may be used on non-finished surfaces.

H. After encapsulant has dried, remove floor, wall, and ceiling plastic carefully by folding inwards into bundles and bagged for disposal. **NOTE**: Final barriers are not to be removed until work is completed.

I. With critical barriers in place, negative pressure system operating, and immovable objects covered with plastic sheeting, perform a second cleaning as was done in the
first cleaning. Wet mop any hard floor surfaces. HEPA vacuum carpeted area surfaces. Hard surfaced flooring such as concrete, terrazzo, VAT and ceramic tile, shall be wet mopped, allowed to dry, and damp mopped a second time with clean mop heads. All mop heads and cleaning cloths are to be discarded in the same manner as asbestos waste.

J. All surfaces are to be left visually clean.

K. Perform visual inspection of work area Consulting Firm and Contractor shall complete Certification of Visual Inspection form found at the end of this section.

L. The Consulting Firm shall take pre-clearance samples as specified in Air Sample Schedule, Section 1.07 as soon as feasible but no longer than twenty four (24) hours after completion of all cleaning work, or as may be specified by the Department. If pre-clearance criteria are met, proceed with air testing for final clearance by Transmission Electron Microscopy (TEM).

M. If pre-clearance criteria is not met, repeat final cleaning until additional tests indicate acceptable levels have been achieved before proceeding with final clearance testing by TEM. Costs associated with additional cleaning and testing shall be borne by the Contractor.

N. After air testing clearance criteria has been met, critical barriers and negative air pressure system can be removed.

3.07 DISPOSAL OF ASBESTOS WASTE

A. All RACM and miscellaneous ACM debris will be transported to the predesignated disposal site in accordance with the guidelines of the U.S. Environmental Protection Agency, Title 40, Part 61, Subpart M, and all local agencies' regulations. Ensure all waste bags/leak-tight container have facilities name, address, and contact person as required by NESHAP. Drums are to be used to transport bagged ACM's as required by regulation(s).

B. EPA NESHAP Category I & II nonfriable ACM may disposed of as C&D waste as allowed by regulation. If nonfriable materials become friable they must then be disposed of as regulated ACM waste in an approved landfill.

C. Workers loading/unloading the asbestos materials and machinery operators will wear respirators and disposable work clothing when handling material at the project and disposal site. Asbestos warning signs shall be posted on vehicle as required by regulation.

D. The bags may be dumped from the drums into the burial site. If drums are used to transport the ACM bags, the bags may be dumped from the drums into the burial site. The drums may be reused. However, if a bag is broken or damaged, the entire drum should be buried.

E. The landfill area used for dumping shall be certified to receive and buy materials contaminated by asbestos.

F. Obtain completed Waste Shipment Record (WSR) for all RACM. WSR must also indicate amount of waste in cubic yards. Submit signed WSR with final report/Project Close-out.

3.08 INSPECTIONS

A. All work procedures detailed in this specification will be strictly adhered to and meet or exceed all current EPA, OSHA, DEP, ASTM and PDL&I regulations.

B. All work shall meet with the approval of the Department. Work which does not meet with the approval shall be determined to be unsatisfactory.

ASBESTOS CERTIFICATION OF VISUAL INSPECTION

Project Name:_____

Project Number:_____

Building Name:_____

Work Area Location:_____

ABATEMENT CONTRACTOR CERTIFICATION

In accordance with Project Specifications and scope of work, the abatement contractor hereby certifies that the Abatement Contractor has visually inspected the work area (all surfaces including pipes, beams, ledges, walls, ceiling and floor, decontamination unit, sheet plastic, etc.) and has found no asbestos dust, debris or residue.

Abatement Contractor Name:_____

Signature:_____ Print Name:_____

Print Title:_____ Date:_____

QUALITY ASSURANCE CONSULTANT

The Quality Assurance Consultant hereby certifies that he/she has accompanied the Abatement Contractor on the visual inspection and verifies that this inspection has been thorough and to the best of his/her knowledge and belief, the Abatement Contractor's certification above is a true and honest one.

Quality Assurance Consultant Name:_____

Inspector Signature:_____
Date:_____

Print Inspector Name:_____

3.08 LOCATIONS

Table 2
Positive Results Summary – Green Building

Sample Identification	Material Description	Location of Material	Analytical Results (Percent Asbestos Content and Type)	Physical Condition	Quantity Observed (Approximate)	OSHA Definition	USEPA Category
1A	TSI Pipe Insulation - Mag Pipe Insulation (White)	Basement Boiler Room Corridor	5% Chrysotile 15% Amosite	Good	250 SF	ACM	RACM
6A	Mudded Pipe Fitting	Basement	5% Chrysotile 15% Amosite	Good	50	ACM	RACM
---	Fire Doors	Throughout	ASSUMED	Good	7	PACM	RACM

END OF SECTION

SECTION 230000

GENERAL REQUIREMENTS FOR MECHANICAL TRADES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.1 GENERAL

A. Applicable portions of all documents listed in the index apply to work of this section.

B. Provisions stated in this section are applicable to all sections of the Division 23 Mechanical Specifications and to all phases of the Mechanical work shown on the drawings.

C. The "Materials and Equipment" paragraph of this section shall take precedence over all related provisions of Division 1 Section, which may conflict with this section.

1.2 SINGULAR NUMBER

A. In all cases where a device or piece of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation. Quantity determinations of all materials and equipment shall be the complete responsibility of the Contractor.

1.3 DEFINITIONS

A. The following are definitions of terms and expressions used throughout Division 23 specifications:

1. Client Agency - Department of Human Services
2. Professional - Martin Rogers Associates, P.C.
3. Provide - Furnish and install.
4. Work - Plant, labor, and material.
5. Directed - Directed by the Professional.
6. Indicated - Indicated by the contract documents

7. Concealed - Hidden from sight; includes items in shafts, pipe and duct spaces, and above ceilings.
8. Exposed - Not concealed; work within equipment rooms and exposed to view by the occupant shall be considered exposed.
9. Piping - Includes pipes, fittings, valves, hangers, and accessories comprising a system.
10. Ductwork - Includes ducts, fittings, housings, plenums, dampers, hangers, and accessories comprising a system.
11. ATC - Automatic Temperature Control.
12. DDC - Direct Digital Control.
13. HVAC - Heating, Ventilating, and Air-conditioning.

1.4 SCOPE OF WORK

A. This Section includes general administrative procedures and requirements for mechanical installations, as well as basic materials and methods of construction for the installation of mechanical systems.

B. The following administrative procedures and requirements are included in this section to expand and supplement the requirements specified in the front end of this specification:
1. Work included
2. Work excluded
3. Intent of drawings
4. Contract drawings
5. Coordination drawings
6. Record drawings
7. Codes, permits, approvals
8. Inspections
9. Materials and equipment
10. Submittals/shop drawings
11. Contractor’s responsibilities - submittals
12. Substitution of materials and equipment
13. Performance of equipment
14. Guaranty/warranty
15. Operating and maintenance manuals
16. Charts
17. Temporary Heat

C. The following basic materials and methods of construction for the installation of mechanical systems are included in this section:
   1. Vibration Control
   2. Accessibility
   3. Examination of site
   4. Dimension of existing structures
   5. Lines, grades, and measurements
   6. Coordination
   7. Delivery, storage, and handling
   8. Protection
   9. Cutting and patching
   10. Equipment installation and connections
   11. Mounting mechanical devices in suspended ceilings

1.5 WORK INCLUDED

A. Work under Division 23 of the specifications of the contract shall include all plant, labor, and material required to complete the work as shown on the drawings, hereinafter specified, or both. Work of this contract shall include but not be limited to the items outlined in each of the Division 23 sections herein. Work generally includes:
   1. HVAC:
      - Miscellaneous demolition as noted and as shown where required.
      - Miscellaneous general construction as noted.
      - Split air handling units, condensing units, and accessories.
      - Heat exchangers, pumps, expansion tanks, air separators, and accessories.
      - Condensate receiver pumps and accessories.
      - Expansion bellows for steam pipings.
      - Make-up air units and accessories.
      - Hydronic piping and specialties as indicated and specified.
      - Hangers and supports, as specified and as shown where required.
      - Thermal insulation as specified and as shown where required.
      - Exhaust systems for toilet rooms, janitor's closets, and ancillary spaces.
      - Ductwork, dampers, and related sheet metal work as noted and as shown where required.
      - Smoke and fire dampers where new ducts penetrate fire/smoke barriers (refer to architect's life safety plan).
      - Anti-ligature, security style ceiling and wall air terminals and louvers as indicated.
      - Interconnection into existing Building Management System (BMS).

- Coordination of ceiling heights and clearances with General and Electrical Contractors necessary to accomplish effective HVAC in harmony with the architectural design.
- Coordination of sizes, weights and floor and wall openings of mechanical equipment with General Contractor.
- Factory start-up for all major HVAC equipment.
- Testing, adjusting, and balancing of all work installed.
- Client Agency training on operation and maintenance of all systems and equipment.

1.6 WORK EXCLUDED

A. All work shown or specified shall be included in the Contract unless specifically mentioned herein.

1.7 INTENT OF DRAWINGS

A. The Contractor generally responsible for the trade of a specific drawing shall provide all work indicated on that drawing unless explicitly indicated otherwise. For example:
   1. H-# drawings - HVAC Contractor
   2. P-# drawings - Plumbing Contractor
   3. F-# drawings - Fire Protection Contractor

B. Work may include items that may relate to other major trades. Specifically, all work indicated on the "H" drawings (HVAC) shall be provided by the HVAC Contractor unless specifically indicated to be provided by others. The same principle shall apply to "P" drawings (Plumbing), "FP" drawings (Fire Protection), etc.

1.8 CONTRACT DRAWINGS

A. Drawings that constitute a part of this contract indicate the general arrangement of piping, ductwork, accessories, equipment, and other work. It is the intent of these drawings and specifications to describe a complete and integrated system. It is understood that while the drawings may not show every pipe, valve, damper, and detail, all equipment and accessories that are reasonably inferable from the drawings and specifications as being necessary for the completion and proper performance of the work shall be included even though not specifically mentioned. What is called for on either the drawings or in the specifications shall be as binding as if called for on both.

B. It is understood that while the drawings shall be followed as closely as circumstances will permit, the Contractor is held responsible for the proper installation of materials and equipment to the true intent and meaning of plans and specifications. If any equipment, piping, or ductwork cannot be installed as shown, the Contractor shall consult with the Professional before making any changes.

1.9 COORDINATION DRAWINGS

A. The contractor shall prepare coordination drawings for the building. Drawings shall be coordinated among all trades and shall be generated in Revit.

B. Coordination drawings shall be prepared to a scale of 1/4”=1’-0” or larger, detailing major elements, components, and systems of mechanical equipment and materials in relationship to other systems, installations and building components.

C. Coordination drawings shall include plans of each area and sections of congested area.

D. Coordination drawings shall:
   1. Indicate the proposed locations of any piping, ductwork, equipment and materials relating to the following:
      a. Exterior wall and foundation penetrations
      b. Equipment pads and bases
      c. Clearances for installing, servicing and maintaining equipment, including tube removal, filter removal and space for equipment disassembly required for periodic maintenance.
      d. Equipment service connections and support details.
      e. Ceiling plenums, chases, shafts, trenches, and other tight and congested spaces
      f. Duct system layout, include elbows, radii, and accessories.
   2. Indicate the proposed scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
   3. Include floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
   4. Include reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.10 RECORD DRAWINGS

A. During construction, the Contractor shall maintain a record set of contract drawings, and shall record on this set in colored pencil all deviations from the original in pipe, duct, or equipment sizes, locations, and other pertinent details.

B. Upon completion of the work, Contractor shall forward these marked prints to the Professional for review.

1.11 CODES, PERMITS, APPROVALS

A. All required local, state and utility company permits and approvals shall not be obtained by the Contractor. The design Professional shall submit to the Pennsylvania Department of Labor and Industry for all Construction permits. Fees do not apply.

B. All persons digging at the site shall notify PA ONE CALL at 1-800-272-1000.

C. All HVAC work shall comply with all applicable provisions of the International Building Codes (IBC), latest edition adopted by the Commonwealth of Pennsylvania, including the International Mechanical Code (IMC).

D. All HVAC work shall be subject to all provisions of the National Fire Code, including NFPA-90a and 90b.

E. All work shall meet the requirements and standards of the several Utility Company(s) serving the project. Install and test backflow preventers in accordance with regulations of the serving utility company.

F. All pressure vessels shall be under the jurisdiction of the PA Department of Labor and Industry, Bureau of Occupational and Industrial Safety Boiler Division.

G. All materials furnished shall meet the ASTM Specifications latest revisions.

H. All electrical work shall be in conformance with the latest edition of the National Electrical Code (NEC).

I. The domestic steam to hot water heaters and steam heat exchangers shall be inspected by FM Global Insurance Co.

J. In all cases, the local Authority-Having-Jurisdiction (AHJ) has the right to impose a higher standard of care than the basic codes listed herein. The contractor shall be familiar with the requirements of and, if unsure, consult with the local AHJ, and make due allowance for more stringent stipulations if necessary. The contractor shall be responsible for all additional work and related costs to comply with the requirements of the local AHJ where such requirements differ from those listed in the basic building code(s).

1.12 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be new, the best of their respective kinds, and suitable for the conditions and duties imposed on them at the building. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

B. All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, and any other imperative information in order to facilitate their maintenance or replacement. The nameplate of a subcontractor or distributor will not be acceptable.

C. All equipment requiring electrical service shall be UL labeled. If a UL label is not available from the manufacturer, when requested or required by the local authority having jurisdiction, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Client Agency. Submit data indicating compliance with standards prior to installation.

D. The contractor understands that:
1. The Professional will use their own judgment in determining whether or not any materials, equipment or methods offered for review as an equivalent are equivalent to those specified.
2. The decision of the Professional on all such questions of equivalency is final.
3. Any acceptable material, equipment, and methods will be provided <u>at no increases in cost to the Client Agency.</u>

1.13 SUBMITTALS AND SHOP DRAWINGS

A. After receiving approval of the source of supply list; furnish catalog data, dimensional data, performance specifications, etc., in sufficient detail to properly identify and judge each item. Each item or equipment proposed shall be a standard product of the approved manufacturer.

B. Samples, drawings, specifications, catalogs, etc., submitted for review shall be dated, properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name, and name of job.

C. Review of shop drawings or samples by the Professional shall not relieve the Contractor of responsibility for any deviation from the requirements of the contract documents. Deviations from the contract documents will only be allowed if all the following are satisfied:
- The Contractor has informed the Professional in writing of all deviations at the time of submission,
- The Contractor has noted the deviation on the shop drawings,
- The Professional has acknowledged, in writing, the specific deviation.

D. In any event, the Professional's review shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.

E. No materials or equipment shall be purchased, delivered to the site, or installed until they have been reviewed by the Professional. Review of any submittal shall not relieve the Contractor of responsibility for deviation from the drawings or specifications, nor shall it relieve the Contractor from errors in the submittals. Dimensions and quantities shall, in all cases, be the complete responsibility of the Contractor.

F. Subsequent to the Professional's review of a submittal, it shall be marked with one or more comments as defined below:
- No Exceptions Taken: The contractor may proceed using the reviewed material,
- Note Markings: The contractor may proceed using the reviewed material provided corrective action is taken on all comments noted on the submittal,
- Comments Attached: Same as "Note Markings", except that comments have been noted on a supplemental attachment,
- Contractor Confirm: The contractor shall respond in writing to all comments including confirmation that corrective action will be taken on all comments noted prior to proceeding with the work,
- Resubmit: The contractor shall respond to all comments noted, revise shop drawings accordingly, and resubmit for review,
- Rejected: The proposed material or equipment does not comply with the requirements of the contract documents and may not be used for this project.

G. Upon receipt of written notice from the Professional that the material, equipment, or methods have been reviewed and marked “no exceptions taken”, “Note Markings”, or “Comments Attached”, the Contractor may proceed with the reviewed material, equipment, or methods. The Contractor assumes full responsibility for and shall make, at no expense to the Client Agency, all changes or adjustments in construction that may result by the use of such approved materials, equipment or methods, including electrical and other services provided under other divisions of this specification. In the event of any adverse decisions by the Professional, no claim of any sort shall be made or allowed against the Professional or the Client Agency.

H. If material or equipment is installed prior to receipt by the contractor of submittals marked “no exceptions taken”, “note markings”, or “comments attached”, the Contractor shall be liable for its removal and replacement at no extra cost to the Client Agency.

I. Sufficient sets shall be submitted to allow two (2) copies to be retained by the Professional.

J. Materials and equipment requiring submittals are listed in each section of these specifications.

1.14 CONTRACTORS RESPONSIBILITY - SUBMITTALS

A. The Contractor shall submit a letter with each submittal forwarded to the Professional’s office for review certifying that they have personally reviewed the material submitted and found it to be satisfactory for this project. This certification shall cover dimensional checking as well as cross checking with the Architectural, HVAC, and/or Electrical documents to insure that no changes will be required in other contracts.

B. Any material submitted to the Professional’s office without this Contractor's certification will be returned without action.

C. Whenever alternate equipment is submitted, it shall be accompanied by a 1/4" - 1'0" scale drawing of the mechanical equipment room showing the alternate equipment, all clearances, etc. Submittals without this information will be returned without review or comment.

1.15 SUBSTITUTION OF EQUIPMENT

A. Substitution of equipment of makes other than those specified, after receipt of the bid, will be approved by the Professional only if:

- The equipment proposed for substitution is equivalent or superior to equipment named in terms of construction, efficiency, and utility, and
- That the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence to work of other Contractors, due to conditions beyond control of the Contractor.

B. To receive consideration, requests for substitutions must be accompanied by documentary proof of equivalence or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

C. In case of a difference in price, the Client Agency shall receive all benefit of the difference in cost involved in any substitution, and the contract altered by change order to credit Client Agency with any savings so obtained.

1.16 PERFORMANCE OF EQUIPMENT

A. All materials, equipment, and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples of such material, equipment, and/or appurtenances shall relieve the HVAC Contractor of his responsibility to turn over the same to the Client Agency in perfect working order at the completion of the work.

B. If the operation, capacity, or performance of any material, equipment, or appurtenance, does not comply with the drawings and/or specification requirements, or is damaged prior to acceptance by the Client Agency, respective item(s) will be considered defective. All defective items shall be removed and replaced with proper and acceptable materials, equipment, and/or appurtenances, or, put in proper and acceptable working order, satisfactory to the Professional, prior to final payment without additional cost to the Client Agency.

1.17 GUARANTY/WARRANTY

A. Materials, equipment, and systems furnished under these specifications shall be guaranteed against defects in material, design, and workmanship.

B. Contractor shall provide a list of equipment and the warranty periods as a submittal that will be reviewed by the Client Agency and the design team.

C. The guarantee period shall extend until the later of:

- A period of one (1) year from the date of final acceptance,
- Eighteen (18) months from the date of initial start-up.

D. The Contractor shall replace any material or equipment that comprises a part of any system that develops any defect during the guarantee period, at their expense.

E. All refrigeration equipment, air conditioners, etc. shall be provided with five (5) year extended compressor warranty covering both labor and materials.

F. Contractor shall turn over to the Client Agency all warranties and guarantees upon completion and final acceptance of project.

1.18 OPERATING AND MAINTENANCE MANUALS

A. Contractor shall submit operating and maintenance instructions for all equipment furnished by them.

B. Maintenance and operating instructions shall be manuals prepared by the various manufacturers for the specific equipment furnished. Manuals shall cover such items as start-up procedures, trouble-shooting, periodic maintenance, etc. Advertising literature or catalogs will not be acceptable in this connection.

C. Three (3) sets of the above material shall be submitted to the Professional for review and approval.

D. Final job acceptance date shall be the date stamped on the operating and maintenance instructions and the guarantee period shall generally extend from that date.

1.19 CHARTS

A. Provide permanent type charts, framed under glass, mounted where directed as follows:
1. Valve charts giving valve use, system, and number on tag attached to valve.
2. Equipment and motor list giving system, equipment designation, and motor horsepower.
3. Automatic temperature control schematics and sequences of operation.
4. Lubrication instructions for all equipment giving type of lubricant and frequency.
5. Service organizations with normal and emergency telephone numbers.
6. Abbreviated operating instructions for all mechanical systems.

1.20 TEMPORARY HEAT

A. The existing fin-tube radiation shall be utilized as the temporary heat source (refer to specification section 015000).

PART 2 - PRODUCTS

2.1 VIBRATION CONTROL

A. Vibration isolation devices shall be provided in accordance with Chapter 47, Table 42 ("Selection Guide for Vibration Isolation") of the American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc.'s (ASHRAE) 2003 Application Handbook.

2.2 ACCESSIBILITY

A. Locate all equipment that must be serviced, operated, or maintained, in fully accessible locations. Equipment shall include, but not be limited to air handling units, coils, valves, motors, controllers, dampers, drain points, traps, strainers, etc. The contractor shall rework, at their expense, any equipment that is deemed inaccessible to the satisfaction of the Professional.

B. Where required or directed by the Professional, provide access panels for access to all equipment where no other means of access is available. All access panels shall be of sufficient size to service and remove the equipment for which they are provided, and in no case shall they have a clear opening less than 8" x 8". Access panels shall be set flush with finished surface and shall be held securely in place by means of integral anchoring lugs.

C. In finished walls they shall be smooth, polished nickel bronze access covers and not less than 8" x 8" openings.

D. Those in floors shall be square nickel bronze non-slip scoriated access covers.

E. Access panels in fire rated walls, floors, shafts, and partitions shall be labeled as such and shall match the rating of the adjacent construction.

F. Access panels larger than 12" x 12" shall be of steel construction, having frames designed to suit the various locations and materials to which they are attached. The frames shall be rabbeted to receive cover and set flush with finished wall or ceiling surface. Covers shall be of rustproof furniture steel of not less than #14 gauge, and

shall be secured with suitable clips and locking cams or countersunk screws. Covers shall be flush with the frames and finished wall or ceiling surface.

G. Where accessible or removable ceilings are provided, ceiling panels or tiles may be removed to serve as access panels.

H. In general, access panels will not be indicated on the drawings. It shall be the Contractor's responsibility to anticipate these needs and to provide access panels as previously specified.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE

A. Contractor shall familiarize themselves with all drawings and documents for the entire project.

B. By virtue of submitting a proposal, Contractor accepts the fact that tight conditions will likely occur at various locations. No extras will be approved for necessary variations and/or adjustments that may be required to resolve interferences.

C. Details of proposed changes found necessary by field conditions or other causes shall be submitted to the Professional for approval before proceeding with any such change.

D. No extra compensation will be allowed on account of a difference between actual dimensions and measurements at the site and those indicated on the drawings.

3.2 DIMENSIONS OF EXISTING STRUCTURES

A. Where the dimensions and locations of existing structures are of critical importance in the installation or connection of new work, verify such dimensions and locations in the field before the fabrication of any material or equipment that is dependent on the correctness of such information.

B. This stipulation applies specifically to existing sewer lines, manholes, etc. Establish exact invert of existing lines before beginning installation of any new work.

3.3 LINES, GRADES, AND MEASUREMENTS

A. Make all measurements and check all dimensions necessary for the proper construction of the work called for by the drawings and specifications. During the prosecution of the work, make all necessary measurements to prevent misfitting in said work, and for the accurate construction of the entire work.

3.4 COORDINATION

A. HVAC Contractor shall plan all sequences of their portion of the project so that the work proceeds with a minimum of interference with other trades. They shall cooperate with all other Contractors in coordinating the locations of piping, ducts, etc., with lighting fixtures, structural members, sprinkler heads, etc.

B. HVAC Contractor shall check all project drawings prior to installing any equipment, pipes, ducts, etc. Any conflicts that become apparent as a result of cross checking drawings shall be resolved with the Professional prior to any work being done. Minor adjustments in location, size, and type of materials necessary to work out any interference shall be made at no extra cost. Being installed "first" in any particular situation will not be considered a factor in the proper resolution of a conflict.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification; adequately packaged and protected to prevent damage during shipment, storage, and handing.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. If any materials or equipment are found to be damaged or in poor condition at the time installation, the Professional may, at their discretion, order the Contractor to furnish and install new materials or equipment at no additional expense to the Client Agency.

3.6 PROTECTION

A. Protect all work, equipment, and materials at all times. All pipe openings shall be capped and plugged during installation.

B. All necessary precautions shall be taken to prevent damage to any work, materials, or equipment furnished by the Contractor. The Contractor shall be held responsible for all

damage incurred to his work, materials, and equipment until his portion of the project is fully and finally accepted.

C. Plumbing Contractor shall adequately cover and protect all plumbing fixtures as may be necessary until completion of the work. Plumbing Contractor shall be responsible for damage or breakage to fixtures and shall make good such damaged items at no cost to the Client Agency.

D. Drainage lines shall be kept free of dirt, concrete, or debris during the course of construction. The contractor shall correct any blockages resulting from the above.

E. Carefully make-up piping or accessories having polished, plated, or finished surfaces to avoid scarring. Protect fixtures or equipment having finished surfaces before, during, and after installation with special protective coatings for this purpose.

F. Do not install exposed polished metal fittings, parts, and devices, until adjoining tile or masonry has been finally acid cleaned.

G. All equipment, devices, controls, and motors shall be tightly covered and protected during construction up to the time of operation. Protection shall be arranged and of such design to prevent damage by infiltration of dust, dirt, debris, moisture, chemicals, or water. Minimum protection shall be by covering with transparent plastic sheeting to the satisfaction of the Professional.

H. The HVAC Contractor shall likewise protect from damage all materials, new and existing, turned over to them by others (including the Client Agency) for installation. The Contractor shall replace any material that becomes damaged at their expense.

3.8 CUTTING AND PATCHING

A. HVAC Contractor shall do all cutting necessary to properly install their materials, except as noted hereafter. This shall include cutting of existing concrete floors and walls. Cutting and patching of every nature required in connection with this Contract shall be done with mechanics experienced in their respective lines of work. All patching shall match adjacent finishes.

B. All cutting in the building shall be done with great care so as not to leave an unsightly surface that may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through fault of the Contractor, they shall be required to correct such deficiencies to the satisfaction of the Professional.

C. All holes for piping shall be core drilled through existing concrete floors and walls.

D. No cutting of structural members shall be done until approval has been received from the Professional.

E. HVAC Contractor(s) shall do all patching required to restore the substrate to a condition that will readily receive new finishes. The General Contractor shall provide all new finishes; tile, plaster, paint, etc.

F. HVAC Contractor shall provide the General Contractor or any other Contractors, which may be affected by his work, locations, and sizes of chases, sleeves, and openings required for installation of pipes, ducts, and other equipment. This information shall be presented to the General Contractor previous to pouring concrete or erecting walls to avoid unnecessary cutting and patching.

G. If openings are omitted or are incorrect through failure of the contractors to follow these instructions, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Professional.

3.9 EQUIPMENT INSTALLATION AND CONNECTIONS

A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer’s instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

B. Any conflicts between the installation instructions indicated on the contract documents and the manufacturer’s instructions and recommendations shall be brought to the attention of the Professional for resolution. The Professional’s decision as to the final equipment installation and connections is final and any modifications necessary to obtain such an installation shall be made at no expense to the Client Agency.

3.10 MOUNTING MECHANICAL DEVICES IN SUSPENDED CEILINGS

A. Support light troffers, air diffusers, grilles, etc. by supplementary hangers located within 6" of each corner. If the weight of the components causes the total dead load to exceed deflection capability of the main runners or cross runners, the components shall be supported independently of the suspension system by the installer of the components placed in ceiling.

B. Contractor shall carefully check existing suspension system for adequacy and completeness. He shall also test its supporting strength where additional weights are to be added due to changes of the existing HVAC or Electric systems.

END OF SECTION 230000

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Grout.
   6. HVAC Demolition
   7. Equipment installation requirements common to equipment sections.
   8. Concrete bases.
   9. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, 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 chases.

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.

1.4 SUBMITTALS

A. Welding certificates.

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 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.

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 to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 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.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:
1. CPVC Piping: ASTM F 493.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

F. 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.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements**:** EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Carbon steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
   1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Client Agency.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying 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. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. 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. 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. 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 Non-pressure Piping: Join according to ASTM D 2855.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

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 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. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 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 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.

D. Install equipment to allow right of way for piping installed at required slope.

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. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   2. Place and secure anchorage devices. Use supported equipment manufacturer's 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. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   5. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 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 HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for HVAC 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.

END OF SECTION 230500

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged HVAC equipment. Specific electrical requirements (i.e. horsepower and electrical characteristics) for HVAC equipment are scheduled on the Drawings.

1.3 GENERAL

A. Electrical Contractor will do all power wiring necessary for the proper operation of all equipment furnished under the HVAC Contract unless specifically identified hereinafter.

B. HVAC Contractor shall provide all necessary electrical devices required for all equipment that they furnish, except remote mounted starters and overload protections that are shown on Electrical drawings. This shall include thermostats, relays, motorized valves, dampers, control elements, etc. to make the HVAC systems complete and operable.

C. Starters and overload protection will typically be shown on the Electrical drawings and provided under Division 26. Starters and overload protection shall be considered part of the HVAC Contract only when they are specified in other division 23 sections to be integral with the HVAC equipment regardless of what drawing on which they are shown.

D. Any disconnect switches, fused or non-fused, required in addition to the safety disconnect switch provided by the Electrical Contractor, shall be provided by this Contractor.

E. All electrical equipment and control devices shall meet NEMA Specifications. Unless noted in schedules otherwise, all 1 HP and larger motors shall be three-phase, 60 Hertz, and motors less than 1 HP shall be single phase, 60 Hertz.

F. HVAC Contractor shall furnish detailed wiring diagrams for all associated electrical work to be done by the Electrical Contractor as hereinafter specified.

G. Exposed low voltage wire shall be control cable in armor cable.

H. Concealed low voltage wire may be control cable.

1.4 REFERENCES

A. NEMA Standards MG 1: Motors and Generators.

B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standard 250: Enclosures for Electrical Equipment.

D. NEMA Standard KS 1: Enclosed Switches Comply with the NEC.

1.5 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.6 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

1.7 DEFINITIONS

A. Power Wiring
1. All wiring from the power source (panel boards or switchboard) through the disconnect switch, or disconnect switch and starter, to the motor or terminal block on the equipment, including final connections.
2. This shall include wiring through line voltage thermostats where provided for the control of miscellaneous mechanical equipment.
3. All feeder and branch circuit conductors and conduit shall be the responsibility of the Electrical Contractor unless otherwise noted.
4. Electrical Contractor shall verify the exact location of line voltage thermostats, disconnects and combination disconnects and starters when not indicated on the drawings.

B. Control Wiring
1. All other wiring required, whether line voltage or low voltage to provide for the operation of the equipment shall be considered as control wiring.
2. HVAC Contractor shall do all control wiring necessary to interconnect instrumentation to sensing elements, indicators, etc. All wiring shall conform to the N.E.C. and the control manufacturer's requirements.

PART 2 - PRODUCTS

2.1 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.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 MOTORS

A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
   1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
   2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
   3. 2-speed motors shall have 2 separate windings on poly-phase motors.
   4. Temperature Rating: rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
   5. Starting capability: frequency of starts as indicated by automatic control system and not less than 5 evenly time spaced starts per hour for manually controlled motors.
   6. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
   7. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
      a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
      b. Bearings: ball or roller bearings with inner and outer shaft seals; regreasable, except permanently sealed where motor is normally inaccessible for regular maintenance; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
      c. Enclosure Type: open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.
      d. Overload Protection: built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
      e. Noise Rating: "Quiet"
      f. Efficiency: "Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, test method B.
      g. Nameplate: indicate the full identification or manufacturer, ratings, characteristics, construction, special features and similar information.

2.4 STARTERS, ELECTRICAL DEVICES, AND WIRING

A. Motor Starter Characteristics:
   1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.
   2. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.

B. Manual Switches shall have:
   1. Pilot lights and extra positions for multi-speed motors.
   2. Overload protection: melting alloy type thermal overload relays.

C. Magnetic Starters:
   1. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
   2. Trip-free thermal overload relays, each phase.
   3. Interlocks, pneumatic switches, and similar devices as required for coordination with control requirements of Division – 230900 “Facility Management and Control System (FMCS)”.
   4. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
   5. Externally operated manual reset.
   6. Under-voltage release or protection.

D. Motor Connections:
   1. Flexible conduit, except where plug in electrical cords are specifically indicated.

2.5 VARIABLE FREQUENCY DRIVES

A. Description: NEMA ICS 2, variable-frequency controller, listed and labeled as a complete unit and arranged to provide variable speed of a standard NEMA MG 1, Design B, 3-phase, induction motor by adjusting output voltage and frequency.

B. Design and Rating: Match load types such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Isolation Transformer: Match transformer voltage ratings and capacity to system and motor voltages; and controller, motor, drive and load characteristics.

D. Output Rating: 3-phase, 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.

E. Output Rating: 3-phase, 6 to 66 Hz, with torque constant as speed changes.

F. Output Rating: 3-phase, 60 to 120 Hz, with horsepower constant throughout speed range.

G. Starting Torque: 100 percent of rated torque or as indicated.

H. Speed Regulation: Plus or minus one percent.

I. Ambient Temperature: 0 to 40 deg. C.

J. Efficiency: 95 percent minimum at full load and 60 Hz.

K. Isolated control interface allows controller to follow 1 of the following over an 11:1 speed range:
   1. Electrical Signal: 4 to 20 mA at 24V.
   2. Pneumatic Signal: 3 to 15 psig.

L. Internal Adjustability: Include the following internal adjustment capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to 22 seconds.
   4. Deceleration: 2 to 22 seconds.
   5. Current Limit: 50 to 110 percent of maximum rating.

M. Multiple-Motor Capability: Controller suitable for service to multiple motors and furnished with a separate overload relay and protection for each controlled motor. Shut off the controller and motors served by it when an overload relay is tripped.

N. Self-protection and reliability features include the following:
   1. Input transient protection by means of surge suppressers.
   2. Snubber networks to protect against malfunction due to system voltage transients.
   3. Motor Overload Relay: Adjustable and capable of NEMA 250, Class 10 performance.
   4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
   5. Instantaneous overcurrent tri.
   6. Loss of phase protection.

7. Under and over voltage trips.
8. Over temperature trip.
9. Short circuit protection.

O. Automatic Reset/Restart: attempt 2 restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Restarting during deceleration will not damage controller, motor or load.

P. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.

Q. Status Lights: Door mounted LED indicators to indicate the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

R. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

S. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate controller output current, voltage, and frequency.

T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch indicator lights set and indicate mode selection.

U. Integral disconnect.

V. Bypass Controller: NEMA ICS 2, full voltage, non-reversing motor controller, provides across the line starting capability in manual bypass mode. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode.

W. Isolating Switch: non-load-break switch arranged to isolate variable-frequency controller and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

X. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

PART 3 - EXECUTION

3.1 COORDINATION OF RESPONSIBILITIES

A. Refer to coordination matrix on the Contract drawings.

END OF SECTION 230513

SECTION 230516

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Packed expansion joints.
   2. Packless expansion joints.
   3. Alignment guides and anchors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

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

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Metal, Compensator Packless Expansion Joints MCEJ-01:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Flex-Hose Co., Inc.
      b. Flex-Weld; a division of Kelco.
      c. Metraflex Company (The).
   2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
   3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
   4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
   5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.
      a. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.
   6. Configuration for Steel Piping: Multi-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
      a. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged.

B. Flexible-Hose Packless Expansion Joints FHEJ-01:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Flex-Hose Co., Inc.
      b. Flex-Weld; a division of Kelco.
      c. Metraflex Company (The).
   2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
   3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
   4. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.
      a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.

2.3 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides AG-01:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Advanced Thermal Systems, Inc.
      b. Flex-Hose Co., Inc.
      c. Flex-Weld; a division of Kelco.
   2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A36/A36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
   3. Washers: ASTM F844, steel, plain, flat washers.
   4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Stud: Threaded, zinc-coated carbon steel.
      b. Expansion Plug: Zinc-coated steel.
      c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
   a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install packed-type expansion joints with packing suitable for fluid service.

C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:
   1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230518

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Escutcheons.
   2. Floor plates.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

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.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
      h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
      i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
      j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
      k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 230518

SECTION 230519

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermo-wells.
   3. Dial-type pressure gages.
   4. Gage attachments.

1.3 SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

C. Product certificates.

D. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      c. Weiss Instruments, Inc.
      d. Or equal as approved by Professional.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and red organic liquid.
6. Tube Background: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Air-Duct Installation: With ventilated shroud.
   b. Design for Thermo-well Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 THERMOWELLS

A. Thermo-wells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI .
   4. Material for Use with Steel Piping: CRES or CSA.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermo-wells for insulated piping and tubing.
   11. Bushings: For converting size of thermo-well's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Trerice, H. O. Co.
      b. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      c. Weiss Instruments, Inc.
      d. Or equal as approved by Professional.
   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type(s); cast aluminum; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Non-reflective aluminum with permanently etched scale markings graduated in psi.
   8. Pointer: Dark-colored metal.
   9. Window: Glass.
   10. Ring: Brass.
   11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermo-wells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees.

B. Install thermo-wells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermo-wells with extension on insulated piping.

D. Fill thermo-wells with heat-transfer medium.

E. Install direct-mounted thermometers in thermo-wells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermo-wells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and siphon fitting in piping for each pressure gage for steam.

L. Install flow indicators in piping systems in accessible positions for easy viewing.

M. Assemble and install connections, tubing, and accessories between flow-measuring elements and flow meters according to manufacturer's written instructions.

N. Install flow meter elements in accessible positions in piping systems.

O. Install differential-pressure-type flow meter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

P. Install permanent indicators on walls or brackets in accessible and readable positions.

Q. Install connection fittings in accessible locations for attachment to portable indicators.

R. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

S. Install thermometers in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Two inlets and two outlets of each hydronic heat exchanger.
   3. Outside-, return-, supply-, and mixed-air ducts.

T. Install pressure gages in the following locations:
   1. Discharge of each pressure-reducing valve.
   2. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

B. Connect flow meter-system elements to meters.

C. Connect flow meter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be the following:
   1. Industrial-style, liquid-in-glass type.

B. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:
   1. Industrial-style, liquid-in-glass type.

C. Thermometers at inlets and outlets of each hydronic heat exchanger shall be the following:
   1. Industrial-style, liquid-in-glass type.

D. Thermometer stems shall be of length to match thermo-well insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale range for Heating Hot Water Piping: 0 to 250 deg F.

B. Scale range for Steam and Steam-Condensate Piping: 0 to 250 deg F.

C. Scale Range for Air Ducts: Minus 40 to plus 160 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
1. Liquid-filled, direct, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale range for Heating Hot Water Piping: 0 to 100 psi.

B. Scale range for Steam Piping: 0 to 160 psi.

END OF SECTION 230519

SECTION 230523

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Bronze ball valves.
2. High-performance butterfly valves.
3. Bronze swing-check valves.
4. Iron swing check valves.
5. Bronze gate valves.
6. Bronze globe valves.

B. Related Sections:
1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance: ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.; Apollo Valves.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded.
      g. Seats: PTFE or TFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.

2.3 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. NIBCO INC.
      c. Victaulic
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-68.
      b. CWP Rating: 285 psig at 100 deg F.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
      e. Seat: Reinforced PTFE or metal.
      f. Stem: Stainless steel; offset from seat plane.
      g. Disc: Carbon steel.
      h. Service: Bidirectional.

B. Class 300, Single-Flange, High-Performance Butterfly Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. NIBCO INC.
      c. Victaulic.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-68.
      b. CWP Rating: 720 psig at 100 deg F.
      c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
      d. Body Material: Carbon steel, cast iron, or ductile iron.
      e. Seat: Reinforced PTFE or metal.
      f. Stem: Stainless steel; offset from seat plane.
      g. Disc: Carbon steel.
      h. Service: Bidirectional.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Milwaukee Valve Company.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 200 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. Milwaukee Valve Company.
      c. NIBCO INC.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.5 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Clear or full waterway.
      e. Body Material: ASTM A 126, gray iron with bolted bonnet.
      f. Ends: Flanged.
      g. Trim: Bronze.
      h. Gasket: Asbestos free.

B. Class 250, Iron Swing Check Valves with Metal Seats:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.

2. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
   c. NPS 14 to NPS 24, CWP Rating: 300 psig.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Bronze.
   h. Gasket: Asbestos free.

2.6 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.; Crane Valve Group; Stockham Division.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
      d. Ends: Threaded or solder joint.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, NRS Bronze Gate Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Milwaukee Valve Company.
      b. NIBCO INC.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 300 psig.
      c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.

d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.7 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Stockham Division.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. Or equal as approved by Professional.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. Or equal as approved by Professional.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.

h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully-closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow and in horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.
   2. Throttling Service, Except Steam: ball, or butterfly valves.
   3. Throttling Service, Steam: Globe or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: One piece, full port, bronze with bronze trim.
   3. Bronze Swing Check Valves: Class 125, bronze disc.
   4. Bronze Gate Valves: Class 125, NRS bronze.
   5. Bronze Globe Valves: Class 125, bronze, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Class 150 or Class 300, single flange.
   2. Iron Swing Check Valves: Class 125 or Class 250, metal seats.

3.6 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe Sizes NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Class 300, single flange.
   2. Iron Swing Check Valves: Class 250, metal seats.

END OF SECTION 230523

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.
6. Miscellaneous materials.

B. Related Sections:
1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fitting Industry, Inc.

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Equipment supports.
   3. Metal framing system.

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Non-staining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-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 for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. 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.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. 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.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 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.
   5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

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 a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-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 carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
   4. Pipe Hangers (MSS Type 5): for suspension of pipes NPS ½ to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   5. Adjustable, Swivel Split-or Solid –Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 6.
   6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
   7. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS ½ to NPS 6.
   8. Adjustable Swivel Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS ½ to NPS 6.
   9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 6.
   10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 6.
   11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

13. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 6, from single rod if horizontal movement caused by expansion and contraction might occur.
17. 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.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 6 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment 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.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
   3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
   4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
   5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
   6. C-Clamps (MSS Type 23): For structural shapes.
   7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
   8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
   9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
   10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
   11. 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.
   12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
   13. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
   14. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   3. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548.13

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Elastomeric isolation mounts.
2. Open-spring isolators.
3. Housed-spring isolators.
4. Restrained-spring isolators.
5. Housed-restrained-spring isolators.
6. Pipe-riser resilient support.
7. Resilient pipe guides.
8. Elastomeric hangers.
9. Spring hangers.
10. Snubbers.
11. Restraints - rigid type.
12. Restraints - cable type.
13. Restraint accessories.

B. Related Requirements:
1. Section 220548 "Vibration Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

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.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7 and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design system.

B. Consequential Damage: Provide additional restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-05 so that failure of a non-essential or essential HVAC component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

C. Fire/Smoke Resistance: All components that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

D. Component Supports:
1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Elastomeric Isolation Mounts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
2. Mounting Plates:
a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Minimum deflection as indicated on Drawings.
4. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psi.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

8. Minimum deflection as indicated on Drawings.

2.4 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. Vibration Eliminator Co., Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Minimum deflection as indicated on Drawings.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
8. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
9. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
10. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to wind-load forces.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and wind force loads within specified loading limits.

3.2 INSTALLATION OF VIBRATION CONTROL DEVICES

A. Provide vibration control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

D. Equipment Restraints:
   1. Install snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
   2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

3.3 ACCOMMODATION OF DIFFERENTIAL MOTION

A. Provide flexible connections in piping systems where they cross structural joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties" for piping flexible connections.

3.4 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Client Agency, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION 230548.13

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTAL

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.3 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 locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Plastic laminated, self adhesive.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

E. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

F. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
1. Stencil Material: Brass.
2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch numbers.
1. Tag Material: Brass, 0.032-inch, Aluminum, 0.032-inch, or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

B. Valves Schedules: for each piping system, on 8-1/2 x 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially pre-printed, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Letter Color: Black.
   2. Background Color: Yellow.
   3. Minimum Size: 3 x 5-1/4 inches.
   4. Fasteners: Brass grommet and wire.
   5. Content: Large-size primary caption such as “DANGER”, “CAUTION”, or “DO NOT OPERATE”.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. 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 inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:
1. Heating Hot Water Piping:
a. Background Color: Yellow.
b. Letter Color: Black.
2. Steam Piping:
a. Background Color: Black.
b. Letter Color: White.
3. Steam Condensate Piping:
a. Background Color: Black.
b. Letter Color: Blue.
4. Refrigerant Piping:
a. Background Color: Blue.
b. Letter Color: White.

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated, self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units List tagged valves in a valve schedule.

B. Valve-tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following sub-paragraphs.
1. Valve-Tag Size and Shape:
a. Refrigerant: 1-1/2 inches round.
b. Heating Hot Water: 1-1/2 inches round.

c. Steam: 1-1/2 inches round.
d. Steam Condensate: 1-1/2 inches round.

2. Valve-Tag Color:
   a. Refrigerant: Natural.
   b. Heating Hot Water: Natural.
   c. Steam: Natural.
   d. Steam Condensate: Natural.
3. Letter Color:
   a. Refrigerant: Black.
   b. Heating Hot Water: Black.
   c. Steam: Black.
   d. Steam Condensate: Black.

3.6 WARNING TAG INSTALLATION

A. Write required message on, and attach warning tags to equipment and other items where required.

END OF SECTION 230553

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Testing, Adjusting, and Balancing of Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Testing, Adjusting, and Balancing of Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
   3. Testing, adjusting, and balancing of equipment.
   4. Testing, adjusting, and balancing of existing HVAC systems and equipment.
   5. Duct leakage tests verification.
   6. Pipe leakage tests verification.
   7. HVAC-control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by AABC:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC.

B. TAB Specialists Qualifications, Certified by NEBB or TABB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Partial Client Agency Occupancy: Client Agency may occupy completed areas of building before Substantial Completion. Cooperate with Client Agency during TAB operations to minimize conflicts with Client Agency's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.

F. Examine equipment performance data, including fan and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.

K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

L. Examine system pumps to ensure absence of entrained air in the suction piping.

M. Examine operating safety interlocks and controls on HVAC equipment.

N. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
   1. Airside:
      a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
      b. Duct systems are complete with terminals installed.
      c. Volume, smoke, and fire dampers are open and functional.
      d. Clean filters are installed.
      e. Fans are operating, free of vibration, and rotating in correct direction.
      f. Variable-frequency controllers' startup is complete and safeties are verified.
      g. Automatic temperature-control systems are operational.
      h. Ceilings are installed.
      i. Windows and doors are installed.
      j. Suitable access to balancing devices and equipment is provided.
   2. Hydronics:
      a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
      b. Piping is complete with terminals installed.
      c. Water treatment is complete.
      d. Systems are flushed, filled, and air purged.
      e. Strainers are pulled and cleaned.
      f. Control valves are functioning in accordance with the sequence of operation.
      g. Shutoff and balance valves have been verified to be 100 percent open.
      h. Pumps are started and proper rotation is verified.
      i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
      j. Variable-frequency controllers' startup is complete and safeties are verified.
      k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."

2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
1. Motors.
2. Pumps.
3. Fans and ventilators.
4. Water-to-water heat exchangers.
5. Condensing units.
6. Condensers.
7. Energy-recovery units.
8. Air-handling units.
9. Dedicated outdoor-air units.
10. Split-system air conditioners.
11. Coils.

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' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

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 total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Review Contractor-prepared shop drawings and Record drawings to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from Construction Manager for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.

3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow, so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
    d. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
6. Measure fan static pressures as follows:
    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.

c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
   a. Balance the return-air ducts and inlets.
   b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
   b. Re-measure and confirm that total airflow is within design.
   c. Re-measure final fan operating data, speed, volts, amps, and static profile.
   d. Mark final settings.
   e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
   f. Verify tracking between supply and return fans.

3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' Record drawings piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   5. Verify that motor controllers are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

D. Measure and record upstream and downstream pressure of each piece of equipment.

E. Measure and record upstream and downstream pressure of pressure-reducing valves.

F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
   1. Check settings and operation of each safety valve. Record settings.

3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design flow.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gauge heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
   3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.
   1. Measure flow in main and branch pipes.
   2. Adjust main and branch balance valves for design flow.
   3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals 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 at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. 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.

G. Verify that memory stops have been set.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
1. Verify that the pressure-differential sensor(s) is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:
1. Adjust pumps to deliver total design flow.
a. Measure total water flow.
1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.

b. Measure pump TDH as follows:
   1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
   2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
   3) Convert pressure to head and correct for differences in gauge heights.
   4) 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.
   5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.
3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
4. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
5. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).

7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
    a. Re-measure and confirm that total flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

D. For systems with flow diversity:
1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.
    a. Measure total water flow.
        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
    b. Measure pump TDH as follows:
        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) 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.
        5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
    c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.11 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

A. Adjust and record water flow to within specified tolerances.

B. Measure and record inlet and outlet water temperatures.

C. Measure and record pressure drop.

D. Check and record settings and operation of safety and relief valves.

3.12 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.13 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).

B. Measure and record entering- and leaving-air temperatures.

C. Measure and record entering and leaving refrigerant pressures.

D. Measure and record operating data of compressor(s), fan(s), and motors.

3.14 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic 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.

B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.

3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

3.15 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.16 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.17 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
4. Check the refrigerant charge.
5. Check the condition of filters.
6. Check the condition of coils.
7. Check the operation of the drain pan and condensate-drain trap.
8. Check bearings and other lubricated parts for proper lubrication.
9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
   1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
   2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
   3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
   4. Balance each air outlet.

3.18 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
   2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
   3. Heating-Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.19 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for

system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.20 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents, including the following:

a. Indicated versus final performance.
b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

16. Test conditions for pump performance forms, including the following:
    a. Variable-frequency controller settings for variable-flow hydronic systems.
    b. Settings for pressure controller(s).
    c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.

e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan speed.
   d. Inlet and discharge static pressure in inches wg.
   e. For each filter bank, 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. Heating-coil static-pressure differential in inches wg.
   i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
   j. Outdoor airflow in cfm.
   k. Return airflow in cfm.
   l. Outdoor-air damper position.
   m. Return-air damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft..
      h. Tube size in NPS.
      i. Tube and fin materials.

j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches, and bore.
      h. Center-to-center dimensions of sheave and amount of adjustments in inches.
   2. Motor Data:
      a. Motor make and frame type and size.
      b. Horsepower and speed.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave and amount of adjustments in inches.
      g. Number, make, and size of belts.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan speed.
      d. Discharge static pressure in inches wg.
      e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System 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.

I. Air-Terminal-Device Reports:
   1. Unit Data:
      a. System and air-handling unit identification.
      b. Location and zone.
      c. Apparatus used for test.
      d. Area served.
      e. Make.
      f. Number from system diagram.
      g. Type and model number.
      h. Size.
      i. Effective area in sq. ft..
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary airflow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final airflow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
   1. Unit Data:
      a. System and air-handling-unit identification.
      b. Location and zone.
      c. Room or riser served.

d. Coil make and size.
e. Flowmeter type.

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.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm.
   g. Water pressure differential in feet of head or psig.
   h. Required net positive suction head in feet of head or psig.
   i. Pump speed.
   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.
   p. Seal type.

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.

L. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.21 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:
   1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
   2. If the second final inspection also fails, Client Agency may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.22 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

END OF SECTION 230593

SECTION 230713

DUCT INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes insulating the following duct services:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
   7. Outdoor, exposed supply and return.

B. Related Sections:
   1. Division 23 Section "HVAC Equipment Insulation."
   2. Division 23 Section "HVAC Piping Insulation."
   3. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 PPM when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Owens Corning; All-Service Duct Wrap.
      d. Or equal as approved by Professional.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Johns Manville; 800 Series Spin-Glass.
      c. Owens Corning; Fiberglas 700 Series.
      d. Or equal as approved by Professional.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-127.
      b. Foster Products Corporation, H.B. Fuller Company; 85-60/85-70.
      c. Marathon Industries, Inc.; 225.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H.B. Fuller Company; 85-50.
      c. Marathon Industries, Inc.; 225.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Corning Corporation; 739, Dow Silicone.
      b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. Speedline Corporation; Polyco VP Adhesive.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products Corporation, H. B. Fuller Company; 30-80/30-90.
      b. Vimasco Corporation; 749.
      c. Sandell; Enviro-Barrier.
      d. Or equal as approved by Professional.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-10.
      b. Foster Product Corporation, H.B. Fuller Company; 46-50.
      c. Marathon Industries, Inc.; 550.
      d. Or equal as approved by Professional.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: 60 percent by volume and 66 percent by weight.
   5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Or equal as approved by Professional.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Or equal as approved by Professional.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. Proto Corporation; LoSmoke.
      c. Speedline Corporation; SmokeSafe.
      d. Or equal as approved by Professional.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Product, Division of ITW; Metal Jacketing Systems.
      b. RPR Products, Inc.; Insul-Mate.
      c. Owens Corning.
      d. Or equal as approved by Professional.
   2. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
   3. Finish and thickness are indicated in field-applied jacket schedules.
   4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
   5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      b. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      c. ABI, Ideal Tape Division; 428 AWF ASJ.
      d. Or equal as approved by Professional.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
      c. ABI, Ideal Tape Division; 491 AWF FSK.
      d. Or equal as approved by Professional.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 370 White PVC Tape.
      b. Compac Corporation; 130.
      c. Venture Tape; 1506 CW NS.
      d. Or equal as approved by Professional.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   4. Adhesion: 64 ounces force/inch in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Venture Tape; 3520 CW.
      c. ABI, Ideal Tape Division; 488 AWF.
      d. Or equal as approved by Professional.
   2. Width: 2 inches.
   3. Thickness: 3.7 mils.
   4. Adhesion: 100 ounces force/inch in width.
   5. Elongation: 5 percent.
   6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-mate Strapping, Seals, and Springs.
      c. ULine.
      d. Or equal as approved by Professional.

B. Insulation Pins and Hangers:

   1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
         2) GEMCO; Perforated Base.
         3) Midwest Fasteners, Inc.; Spindle.
         4) Or equal as approved by Professional.
      b. Base plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; RC-150.
         2) GEMCO; R-150.
         3) Midwest Fasteners, Inc.; WA-150.
         4) Or equal as approved by Professional.
      b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers: Subject to compliance with requirements, but are not limited to, the following:
      a. C & F Wire.
      b. Or equal as approved by Professional.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over compress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
      a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
      b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
   5. Overlap un-faced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not over compress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in unconditioned space.
   4. Indoor, exposed return located in unconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
   7. Outdoor, exposed supply and return.

B. Items Not Insulated:
   1. Factory-insulated flexible ducts.

2. Factory-insulated plenums and casings.
3. Flexible connectors.
4. Vibration-control devices.
5. Factory-insulated access panels and doors.

3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, Supply-Air and Outdoor-Air Duct and Plenum Insulation: Mineral-fiber blanket 2 inches thick and 0.75-lb/cu. ft. nominal density. (R-5)

B. Concealed, Return-Air Duct and Plenum Insulation: Mineral-fiber blanket 2 inches thick and 0.75-lb/cu. ft. nominal density. (R-5)

C. Exposed (Indoor) Supply, Return, and Outdoor Air ductwork: Insulation shall be rigid fiberglass insulation system for hot and cold temperature service consisting of a rigid board of glass fibers with a non combustible vapor barrier facing. Board shall be UL labeled, "K" of 0.23 at 75°F mean temperature, 3 lb. density, 2” thick. Facing shall be type FRK consisting of a foil reinforced Kraft vapor barrier laminate

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed (Outdoor), Supply-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 0.75-lb/cu. ft. nominal density (R-8).

C. Exposed (Outdoor), Return-Air Duct and Plenum Insulation: Mineral-fiber board, 3 inches thick and 0.75-lb/cu. ft. nominal density (R-8).

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
1. None.
2. PVC: 20 mils thick.

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install weather tight aluminum jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Smooth: 0.040 inch thick.

END OF SECTION 230713

SECTION 230716

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Heat Exchangers
   2. Heating, hot-water pumps.

B. Related Sections:
   1. Division 23 Section "Duct Insulation."
   2. Division 23 Section "HVAC Piping Insulation."

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail removable insulation at equipment connections.
   4. Detail application of field-applied jackets.
   5. Detail application at linkages of control devices.
   6. Detail field application for each equipment type.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. 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.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric 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. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. Or equal as approved by Professional.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Owens Corning; SOFTR All-Service Duct Wrap.
      d. Or equal as approved by Professional.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Johns Manville; 800 Series Spin-Glas.
      c. Owens Corning; Fiberglas 700 Series.
      d. Or equal as approved by Professional.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Owens Corning; Fiberglas Pipe and Tank Insulation.
      d. Or equal as approved by Professional.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
      b. BNZ Materials.
      c. Vermiculite.
      d. Or equal as approved by Professional.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aeroseal.
      b. Armacell LLC; 520 Adhesive.
      c. Foster Products Corporation H. B. Fuller Company; 85-75.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-127.
      b. Foster Brand, Products H. B. Fuller Company; 85-60/85-70.
      c. Marathon Industries, Inc.; 225.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-50.
      c. Marathon Industries, Inc.; 225.
      d. Or equal as approved by Professional.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Chemical Company; 739, Dow Silicone.
      b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. Speedline Corporation; Speedline Vinyl Adhesive.
      d. Or equal as approved by Professional.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Foster Products Corporation, H .B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
c. Sandell; Enviro-Barrier.
d. Or equal as approved by Professional.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 46-50.
c. Marathon Industries, Inc.; 550.
d. Or equal as approved by Professional.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:
   1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 30-45.
      c. Marathon Industries, Inc; 405.
      d. Or equal as approved by Professional.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc; 405.
      d. Or equal as approved by Professional.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Or equal as approved by Professional.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      b. Proto Corporation; LoSmoke.
      c. Speedline Corporation; SmokeSafe.
      d. Or equal as approved by Professional.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated tank heads and tank side panels.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. RPR Products, Inc.; Insul-Mate.
      c. Owens Corning.
      d. Or equal as approved by Professional.
   2. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
   3. Finish and thickness are indicated in field-applied jacket schedules.
   4. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.

5. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange and union covers.
   e. End caps.
   f. Beveled collars.
   g. Valve covers.
   h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 428 AWF ASJ.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
      c. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
      d. Or equal as approved by Professional.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ABI, Ideal Tape Division; 491 AWF FSK.
      b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      c. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
      d. Or equal as approved by Professional.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC Tape.
   b. Compac Corporation; 130.
   c. Venture Tape; 1506 CW NS.
   d. Or equal as approved by Professional.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Venture Tape; 3520 CW.
   d. Or equal as approved by Professional.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
   c. ULine.
   d. Or equal as approved by Professional.

B. Insulation Pins and Hangers:
   1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Base plate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
         2) GEMCO; Perforated Base.
         3) Midwest Fasteners, Inc.; Spindle.
         4) Or equal as approved by Professional.
      b. Base plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
      c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
      d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Products: Subject to compliance with requirements, provide one of the following:
         1) AGM Industries, Inc.; RC-150.
         2) GEMCO; R-150.
         3) Midwest Fasteners, Inc.; WA-150.
         4) Or equal as approved by Professional.
      b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. C & F Wire.
      b. Or equal as approved by Professional.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. 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.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation 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 unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
a. Do not weld anchor pins to ASME-labeled pressure vessels.
b. Select insulation hangers and adhesive that is compatible with service temperature and with substrate.
c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
d. Do not over compress insulation during installation.
e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. 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.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Insulate heating hot water loop pumps with 1-inch thick flexible elastomeric. Entire pump body shall be enclosed within an insulating envelope. Install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. 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.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.5 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-Exchanger (Steam-to-Water for Heating Service) Insulation: Mineral-fiber pipe and tank, 2 inches thick.

D. Heating-Hot-Water Pump Insulation: Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

END OF SECTION 230716

SECTION 230719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:
   1. Heating, hot water piping, indoors.
   2. Heating hot-water piping, outdoors
   3. Steam and steam condensate piping, indoors.
   4. Condensate drain piping, indoors.
   5. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:
   1. Division 23 Section "Duct Insulation."
   2. Division 23 Section “HVAC Equipment Insulation.”

1.3 SUBMITTALS

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

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties.
   5. Detail application of field-applied jackets.
   6. Detail application at linkages of control devices.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. 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.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. Or equal as approved by Professional.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 1290, Type I.
1. Products: Subject to compliance with requirements, provide one of the following:
a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.

c. Owens Corning; All-Service Duct Wrap.
d. Or equal as approved by Professional.

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Owens Corning; Fiberglas Pipe Insulation.
d. Or equal as approved by Professional.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
b. BNZ Materials.
c. Vermiculite.
d. Or equal as approved by Professional.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Products Corporation, H. B. Fuller Company; 85-75.
d. Or equal as approved by Professional.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-127.
b. Marathon Industries; 225.

c. Foster Products Corporation, H. B. Fuller Company; 85-60/85-70.
d. Or equal as approved by Professional.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-82.
b. Marathon Industries; 225.
c. Foster Products Corporation, H. B. Fuller Company; 85-50.
d. Or equal as approved by Professional.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Dow Chemical Company; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. Speedline Corporation; Speedline Vinyl Adhesive.
d. Or equal as approved by Professional.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
a. Foster Products Corporation, H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
c. Sandell; Enviro-Barrier.
d. Or equal as approved by Professional.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-10.
b. Marathon Industries; 550.
c. Foster Products Corporation, H. B. Fuller Company; 46-50.
d. Or equal as approved by Professional.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76.
b. Marathon Industries; 405.
c. Foster Products Corporation H. B. Fuller Company; 30-45.
d. Or equal as approved by Professional.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Use sealants that 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," including 2004 Addenda.

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76.
b. Marathon Industries; 405.
c. Foster Products Corporation, H. B. Fuller Company; 95-44.

d. Or equal as approved by Professional.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Or equal as approved by Professional.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. Proto Corporation; LoSmoke.
   c. Speedline Corporation; SmokeSafe.
   d. Or equal as approved by Professional.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.
   d. Or equal as approved by Professional.
2. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
6. Factory-Fabricated Fitting Covers:
   a. Same material, finish, and thickness as jacket.
   b. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
   c. Tee covers.
   d. Flange, union, and valve covers.
   e. End caps.
   f. Beveled collars.
   g. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   d. Or equal as approved by Professional.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
   d. Or equal as approved by Professional.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 370 White PVC tape.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Venture Tape; 1506 CW NS.
   d. Or equal as approved by Professional.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Venture Tape; 3520 CW.
d. Or equal as approved by Professional.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
1. Products: Subject to compliance with requirements, provide one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
c. ULine.
d. Or equal as approved by Professional.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy or 0.062-inch soft-annealed, galvanized steel.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. C & F Wire.
b. Or equal as approved by Professional.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
   a. For below-ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 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. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with 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. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install 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 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.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Pipe Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Heating, Hot Water Supply and Return, 141-200 Deg F: Insulation shall be the following:
1. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick for NPS 1-1/2 inches or less and 2 inches thick for NPS larger than or equal to 1-1/2 inches.

B. Steam and Steam Condensate, above 201-250 Deg F:
1. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches thick for NPS less than 4 inches and 3 inches thick for NPS larger than or equal to 4 inches.

C. Condensate Drain Piping: Insulation shall be the following:
1. Flexible elastomeric, 1/2 inch thick.

D. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
1. Flexible elastomeric, 1-1/2 inch thick.

E. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
1. Flexible elastomeric, 1-1/2 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Flexible Tubing: Insulation shall be the following:
1. Flexible Elastomeric: 1-1/2 inch thick.

B. Refrigerant Suction and Hot-Gas Piping: Insulation shall be the following:
1. Flexible Elastomeric: 1-1/2 inches thick.

C. Refrigerant Liquid Piping: Insulation shall be the following:
1. Flexible Elastomeric: 1-1/2 inches thick.

D. Heating-Hot-Water Supply and Return, 141-200 Deg F: Insulation shall be the following:
1. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Piping, Exposed: (If more than one material is listed, selection from materials list is Contractor's option)
1. Install 0.016 inch thick smooth, aluminum jacket.

END OF SECTION 230719

SECTION 230800

HVAC SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specification sections "General Conditions", "Special Requirements" and "General Requirements" form a 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. General provisions and other mechanical systems are specified in other Sections of Division 23.

B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 23 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 23 shall be familiar with the commissioning plan issued by the Commissioning Agent as it applies to the work of Division 23 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the mechanical equipment and systems provided by this Division.

D. This Section covers HVAC systems commissioning, as required to demonstrate that the equipment and systems of Divisions 23 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, Using Agency’s operating personnel training, and preparation of record drawings.

E. This section does not alter the equipment start-up testing requirements indicated in Divisions 23 of the building specifications. This section is to help define/supplement the requirements of Section 019000 and Section 230800 where applicable.

1.3 QUALITY ASSURANCE

A. The Department shall identify a mechanical commissioning supervisor. The HVAC commissioning supervisor should have a minimum of ten years experience in mechanical contracting. The HVAC commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The HVAC commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outline by the Commissioning Agent. The HVAC commissioning supervisor shall assist the Commissioning Agent in coordinating and executing the required commissioning activities.

1.4 PRIME CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.

B. Assemble all record drawings and all records of Code authority inspections and approvals. Prime Contractor shall review operation and maintenance information and as-built drawings and obtain all documentation from tests for review. Prime Contractor shall document warranty start and dates.

C. The HVAC commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing, and commissioning activities as specified herein with the Commissioning Agent. Specific requirements of the Mechanical Prime Contractor and associated Prime Contractors are identified in this Section and in other Sections of this Division.

D. The Commissioning Agent shall conduct independent verification of installation, pre-functional, start-up and functional testing.

E. HVAC commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:

1. Construction Phase

a. Prime Contractor shall attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and increase in frequency to weekly during the start-up, pre-functional and functional testing phases. Prime Contractor shall assure that all associated Contractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.

b. The Prime Contractor shall provide a report in writing to the Commissioning Agent at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the pre-functional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.

c. Provide the Commissioning Agent with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.

d. Provide documentation to the Commissioning Agent for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Client Agency-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of The Client Agency to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.

e. Develop and submit to Commissioning Agent, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer’s start-up procedures. The Commissioning Agent shall conduct their own pre-functional testing check in parallel with the Prime Contractors.

f. Review the Commissioning Agent's pre-functional checksheets and sign-off on the appropriate areas when Prime Contractor and associated Prime Contractors are complete. The pre-functional test sheets will be developed by the Commissioning Agent. Only when each portion of the pre-functional test sheet is signed off will the respective Prime Contractor be able to move onto the next phase of the start-up and check-out.

g. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Agent for review.

h. Assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

i. Commissioning Agent shall prepare the specific functional test procedures as specified herein. The Prime Contractors shall review the Commissioning Agent's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

j. Commissioning Agent shall prepare a preliminary schedule for HVAC commissioning activities, to include pipe and duct system testing, flushing and cleaning, equipment start-up, and TAB start and completion, for use by the Commissioning Agent and shall update the schedule as appropriate. The Prime Contractor & associated Prime Contractors shall update the commissioning activities and notify any delays in the progress meetings. Prime Contractor & associated Prime Contractors shall notify the Commissioning Agent during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.

k. HVAC equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the Commissioning Agent as specified in other Sections of Division 23.

l. Provide startup testing for all HVAC equipment, including the building automation control system and shall execute the HVAC-related portions of the pre-functional checklists for all commissioned equipment during the startup and initial checkout process. The Commissioning Agent shall

conduct an independent start-up once the respective Prime Contractor is complete with their requirements.

m. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Agent.

n. Correct current Design Engineer punch list and Commissioning Agent deficiency items before functional performance testing can begin. Air and water Testing Adjusting and Balancing shall be completed with discrepancies and problems remedied before functional testing of the respective air or water related systems.

o. The Commissioning Agent shall generate the functional testing procedures and record to the Prime Contractor. The Prime Contractor shall review and provide support to the functional testing process. Prime Contractor shall operate chillers, pumps, etc. and systems in accordance with the Commissioning Agent requirements, open and close disconnects and switch normal and emergency power requirements as directed by the Commissioning Agent and the functional testing procedures.

p. Report in writing to the Commissioning Agent at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, pre-functional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

2. Acceptance Phase. Prime Contractor shall assist and cooperate with the Commissioning Agent in the commissioning process by:

a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.

b. For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the mechanical system and associated controls completed and approved by the Commissioning Agent prior to beginning the test and balance process.

c. Provide a qualified technician to operate the controls as required to assist the TAB Prime Contractor in performing TAB or provide sufficient training for TAB to operate the system without assistance.

d. Provide a TAB representative to assist the Commissioning Agent on conducting a random 10% check of the air and water distribution requirements.
e. Including cost of sheaves and belts that may be required to obtain required equipment performance, as measured by the test and balance effort.
f. Providing test holes in ducts and plenums where directed by TAB to allow air measurements and air balancing. Providing an approved plug.
g. Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning testing.
h. Installing a P/T plug at each water sensor that is an input point to the Control System.
i. Providing skilled technicians to execute starting and operation of equipment.
j. The Commissioning Agent will conduct functional performance testing. The Prime Contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.
k. The commissioning will require full and part load performance verifications as well as seasonal and simulated testing requirements. The Prime Contractor shall be prepared to operate different components of various systems (example, chilled water and hot water systems to generate loading strategies) during the functional testing.
l. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Agent and Design Engineer.
m. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequence of operation to as-built conditions.
n. Maintain on site redline as built drawings and produce final “As-built” drawings for all project drawings and Contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.
o. Provide specified training of The Client Agency’s operating personnel in accordance with the Commissioning Agent’s overview and outline.

p. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
q. Provide updated diagrammatical logic for all TAB adjustments to the system.

3. Warranty Period. During the warranty period, the Prime Contractor shall:

a. Be available during seasonal or deferred functional performance testing conducted by the Commissioning Agent, according to the specifications.
b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.5 TESTING ADJUSTING AND BALANCING PRIME CONTRACTOR RESPONSIBILITIES

A. Six weeks prior to the starting of the Testing Adjusting and Balancing (TAB), the Prime Contractor shall submit to the Commissioning Agent, the qualifications of the site technician(s) for the project, including three (3) name of Contractors and facility managers of recent projects on which the personnel were in charge. The Client Agency and Commissioning Agent will approve the site technician for this job.

B. Three months prior to the start of the TAB, the TAB Agent shall submit a testing plan and approach for each system. The plan shall be reviewed by the Commissioning Agent for review and approval. The submitted plan shall include:

1. Certification that the TAB Prime Contractor has reviewed the construction documents and the systems with the Design Professional and all other respective Prime Contractors to sufficiently understand the design intent for each system
2. An explanation of the intended use of the building control system.
3. All field check-out sheets and logs to be used that lists each piece of equipment to be tested adjusted and balanced with the data cells to be gathered for each.
4. Final test report forms to be used during this process
5. Detailed step by step procedures for TAB work for each system and issue: terminal flow calibration, diffuser proportioning, branch and submain proportioning, total flow calculations, rechecking diversity issues.

6. List all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of each of the test procedures, parameters and formulas to be used.
7. Details of how total flow will be determined (Air: sum of terminal flows via BMS calibrated readings or via hood, pitot tube or flow stations. Water: pump curves, circuit setters, flow station, ultrasonic, etc,
8. The identification and types of measurement instruments to be used and their most recent calibration date.
9. Specific procedures that will ensure that both air and watersides will be operating at there lowest possible pressure at the point where the system will operate.
10. Confirmation that the TAB Prime Contractor understands the outside air ventilation criteria under all conditions and how this will be measured during normal, economizer and unoccupied conditions.
11. Details of how building static, room static and exhaust fan capacity will be checked.
12. Proposed selection points for traverse measurement locations on the as-built documents. Review the placement of the HVAC measurement devices for proper straight runs and accuracy.
13. Plan for formal progress reports including scope and frequency
14. Plan for formal deficiency reports including scope and frequency.

C. TAB Agent shall attend commissioning meetings as directed by the Commissioning Agent and the Contractor.

D. TAB Agent shall communicate in writing to the ATC Contractor and the Commissioning Agent all setpoint and parameter changes made or problems and discrepancies identified during the TAB process that would affect the control loop system set-up and operation.

E. Submit written report of discrepancies, deficit or uncompleted work by others, contract interpretation requests and list of completed tests to the Commissioning Agent at least once per week.

F. After the TAB plan is accepted and two-weeks prior to TAB work, the Commissioning Agent shall conduct a pre-balancing conference. Prior to the pre-balancing conference, the TAB Contractor shall inspect the system readiness for testing and balancing. The

TAB Contractor shall prepare a list of deficiencies and uncompleted work that will effect the TAB process. This list shall be submitted to the Commissioning Agent and the Department.

G. The TAB Agent shall coordinate testing of the fume hood systems with the Commissioning Agent.

H. The TAB Agent shall review the projected schedule and provide, in writing, to the Commissioning Agent and Client Agency's Rep any delays in the schedule and what items will require completion prior to the TAB work.

I. The Commissioning Agent agent shall conduct independent verification of 20% of air and water end-devices for acceptance after the TAB Contractor states in writing that they are complete with Testing & Balancing. The TAB Contractor shall provide a mechanic to assist the Commissioning Agent in this verification and shall include this in the scope and price of the Work.

J. The TAB agent shall submit the TAB report to the Commissioning Agent for his review and comment. All data contained shall be re-verified in the field by the Commissioning Agent. A minimum of ten percent of the airflow readings shall be verified by the Commissioning Agent using his own equipment. All selection points shall be random. Total airflow shall be verified on all mains in the supply and the exhaust ducts.

1.6 AUTOMATIC TEMPERATURE CONTROL PRIME CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.

B. The controls commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing and commissioning activities as specified herein with the Commissioning Agent. Specific requirements of the ATC Contractor and associated Prime Contractors are identified in this Section and in other Sections of this Division.

C. The Commissioning Agent shall conduct independent verification of installation, pre-functional, start-up and functional testing.

D. Controls commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:

1. Construction Phase

a. Attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and increase in frequency to weekly during the start-up, pre-functional and functional testing phases. Prime Contractor shall assure that all associated Prime Contractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.

b. Report in writing to the Commissioning Agent at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the pre-functional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.

c. Provide the Commissioning Agent with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.

d. Provide documentation to the Commissioning Agent for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any Client Agency-contracted tests; points listing; full factory testing reports, if any; and full warranty information, including all responsibilities of The Client Agency to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.

e. Develop and submit to Commissioning Agent, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures. The Commissioning Agent shall conduct their own pre-functional testing check in parallel with the Prime Contractors.

f. Review the Commissioning Agent's pre-functional checksheets and sign-off on the appropriate areas when Prime Contractors are complete. The pre-functional test sheets will be developed by the Commissioning Agent. Only when each portion of the pre-functional test sheet is signed off will the Prime Contractor be able to move onto the next phase of the start-up and check-out.

g. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Agent for review.

h. Assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

i. Commissioning Agent shall prepare for the specific functional test procedures as specified herein. The Prime Contractors shall review the Commissioning Agent's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

j. Commissioning Agent shall prepare with the controls agent a preliminary schedule for Division 23 commissioning activities, to include wiring, instrument installation, calibration, point-to-point verification, sequence of operation testing and emergency operating procedural testing for use by the Commissioning Agent and shall update the schedule as appropriate. The Prime Contractor shall update the commissioning activities and notify any delays in the progress meetings. Prime Contractor shall notify the Commissioning Agent during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.

k. Controls instrument and equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the Commissioning Agent as specified in other Sections of Division 23.

l. Provide startup testing for all HVAC equipment, including the building automation control system and shall execute the HVAC/controls-related portions of the pre-functional checklists for all commissioned equipment during the startup and initial checkout process. The Commissioning Agent shall conduct an independent start-up once the Prime Contractor is complete with their requirements.

m. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Agent.

n. Correct current Design Engineer punch list and Commissioning Agent deficiency items before functional performance testing can begin. Point to point verification shall be completed with discrepancies and problems remedied before functional testing of the respective controls related systems.

o. The Commissioning Agent shall generate the functional testing procedure and record to the ATC Contractor. The ATC Contractor shall review and provide support to the functional testing process. ATC Contractor shall aid in operating chillers, pumps, etc. and systems in accordance with the Commissioning Agent requirements, turn on and off normal and emergency power requirements as directed by the Commissioning Agent and the functional testing procedures.

p. Report in writing to the Commissioning Agent at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, pre-functional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

2. Acceptance Phase. ATC Contractor shall assist and cooperate with the Commissioning Agent in the commissioning process by:

a. Putting all HVAC equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.

b. For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the mechanical system and

associated controls completed and approved by the Commissioning Agent prior to beginning the test and balance process.

c. Provide a qualified technician to operate the controls as required to assist the TAB Prime Contractor in performing TAB or provide sufficient training for TAB to operate the system without assistance.
d. Provide a controls representative to assist the Commissioning Agent on conducting a random 10% check of the air and water distribution requirements.
e. Providing skilled technicians to execute starting and operation of equipment.
f. The commissioning agent will conduct functional performance testing. The Prime Contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.
g. The commissioning will require full and part load performance verifications as well as seasonal and simulated testing requirements. The ATC Contractor shall be prepared to operate different components of various systems (example, chilled water and hot water systems to generate loading strategies) during the functional testing.
h. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Agent.
i. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequence of operation to as-built conditions.
j. Maintain on site redline as built drawings and produce final “As-built” drawings for all project drawings and Contractor-generated coordination drawings. List and clearly identify on the as-built drawings the locations of all airflow stations and sensor installations that are not equipment mounted.
k. Provide specified training of The Client Agency's operating personnel in accordance with the commissioning agent’s overview and outline.
l. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
m. Provide a detailed marked up drawings of all the instruments and their installed location (P&ID) for instruments and components.

3. Warranty Period. During the warranty period, the ATC Contractor shall:

a. Be available during seasonal or deferred functional performance testing conducted by the Commissioning Agent, according to the specifications.
b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 - PRODUCTS

2.1 SYSTEMS TO BE COMMISSIONED

A. The following are systems to be commissioned.

1. Air Handling Units
2. Make-up Air Unit
3. Energy Recovery Ventilation Units
4. Steam to Hot Water Heat Exchangers and Related Pumps
5. Domestic Steam to Hot Water Generators and Related Pumps
6. Heat Pumps
7. Hot Water Systems
8. Exhaust Fans
9. Automatic Temperature Control Systems

2.2 TEST EQUIPMENT

A. All standard testing equipment required to the HVAC portion startup, initial checkout shall be provided by the Prime Contractor responsible for the equipment or system being tested. This includes TAB and controls verification.

B. The commissioning agent shall perform their own system verification and performance check-out. The commissioning agent shall provide their own calibrated equipment as required for this testing.

C. All testing equipment associated with functional performance verification and point-to-point required by the commissioning agent shall be the responsibility of the commissioning agent. All testing equipment associated with the ATC Contractor point-to-point verification shall be the responsibility of the ATC Contractor.

D. Special equipment, tools, and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the Commissioning Agent by the installing Prime Contractor and shall become the property of The Client Agency at project completion as indicated in the specification.

E. Proprietary test equipment and software required by any manufacturer for programming and / or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. The manufacturer shall provide test equipment, demonstrate its use and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of The Client Agency upon successful completion of the commissioning process as required in the specifications.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Prime Contractor shall provide submittal documentation relative to commissioning as required in this Section Part 1.

3.2 STARTUP PLAN AND PRE-FUNCTIONAL TESTING

A. The Prime Contractor and associated Prime Contractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Prime Contractor & associated Prime Contractors shall follow the approved start-up, initial checkout, and pre-functional testing procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the Commissioning Agent or Client Agency's rep.

B. Pre-functional test forms are written by the Commissioning Agent and shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing to may proceed without delays. Sampling strategies shall be used for pre-functional testing for lower-

level components of equipment (e.g. VAV boxes, reheat coils). The pre-functional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The Prime Contractor and associated Prime Contractors shall sign off on the Commissioning Agent's pre-functional test sheets that they are complete and the system is ready. The Commissioning Agent will verify and conduct their own independent verification and start-up in parallel to the Prime Contractor's verification. Any deficiencies identified during this process shall be noted and reviewed by the Prime Contractor and associated Prime Contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the Commissioning Agent.

C. The following procedures shall apply to all equipment and systems to be commissioned.

1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and pre-functional testing plans for all equipment. The primary role of the Commissioning Agent in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all Prime Contractors, shall the equipment be start-up by the respective Prime Contractor. Equipment and systems to be commissioned are identified in this Section Part 2.

2. The start-up and initial checkout plan shall consist of the following as a minimum:

a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

b. First-run checklist for equipment, to include:

- Equipment properly set.
- Alignment of shafts and couplings.
- Adjustment of vibration isolators.
- Piping and equipment properly connected.

- Completion of initial lubrication procedures.
- Clean filters in place, as appropriate.
- Wiring properly connected.
- Electrical overload relays appropriate for load.
- Electrical accessories properly installed and adjusted.
- Controls, safeties, and time switches properly calibrated and set-up
- Verification of direction of motor rotation after final electrical connections by jogging motor.
- Measurements of ampere draw of electric motors and comparison with nameplate rating and with overload heater ratings.
- Proper wiring procedures of instruments and main power systems
- Calibration of all system components

3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line-item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.

4. The Prime Contractor shall submit the startup reports to the Commissioning Agent for review.

D. The Commissioning Agent shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.

E. Two weeks prior or startup, the Prime Contractor shall schedule startup and checkout with The Client Agency and Commissioning Agent. The execution of the startup and checkout shall be directed and performed by the respective Prime Contractor, in accordance with manufacturer's published procedures and with the approved procedures. The Commissioning Agent shall be present for the required startup and checkout of all systems and equipment to be commissioned.

F. Sensor Calibration. Calibration of all sensors shall be included as part of the pre-functional testing and listed on the appropriate test checklists and reports, according to the specified procedures and accuracies for the devices and systems being tested.

G. All Prime Contractor responsible start-up, checkout forms shall be completed and submitted to the Commissioning Agent for review.

3.3 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full, part and seasonal requirements. Systems are tested under various loads and control sequences, such as low cooling and heating loads, component failures, unoccupied modes, fire alarm, etc. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include; testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part and full load). Proper responses such as power failures, freeze conditions, low-oil pressures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing and documents the testing. Each Prime Contractor is required is supply personnel to assist during the functional performance testing where applicable.

B. No system, equipment or component thereof shall be tested until the respective Prime Contractor and has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the Commissioning Agent after the pre-functional testing requirements are complete and signed-off by the Commissioning Agent. Functional Performance Verification will not be conducted until a written notice of completion by the respective Prime Contractor confirming that the system is ready for FPV. The air balancing and water balancing must be complete and the controls must be debugged prior to the performance verification.

C. Functional testing shall be conducted by the Commissioning Agent. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.

D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the

Commissioning Agent and Client Agency's Rep. Beginning system testing before full completion shall not relieve the respective Prime Contractor from fully completing the system, including all pre-functional checklists.

E. The associated Prime Contractor shall provide personnel to operate the systems while functional performance testing is commencing. This shall include but not be limited to; starting and stopping of systems, opening and closing valves to create false loads on the system (with the capabilities of the existing system) and allowing the Commissioning Agent to manipulate the building automation systems to modulate the system requirements.

F. The associated Prime Contractor shall review the commissioning functional performance testing procedure supplied by the Commissioning Agent. After functional testing commences, the Prime Contractor and the Commissioning Agent shall sign the functional test record and provide The Client Agency a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.

G. All Functional Testing must be completed and approved by the Commissioning Agent and The Client Agency before the project will be considered substantially complete.

3.4 DEFERRED TESTING

A. Deferred Testing. The Prime Contractor and associated Prime Contractors shall be available to assist in seasonal testing (Summer, Winter and Intermediate), tests delayed until weather or other conditions building construction is completed, required building occupancy or loading, or other conditions are suitable for the demonstration of equipment or system's performance, as specified. These deferred tests shall be conducted in the same manner as the seasonal tests as soon as possible. Deferred testing shall be executed, documented and deficiencies corrected as specified herein for functional performance testing. Any adjustments or corrections to the O&M manuals and "As built" documents required by the results of the testing shall be made before the seasonal testing process is considered complete.

3.5 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. The Commissioning Agent shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to The Client Agency within two days of test completion. The Commissioning Agent shall review all Prime Contractor startup testing reports and shall submit either a non-compliance report or an approval form to the associated Prime Contractor. The Commissioning Agent shall work with the Prime Contractor and associated Prime Contractors as necessary, to correct and retest deficiencies or uncompleted items. The associated Prime Contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Agent as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the Commissioning Agent shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and a deficiency is identified, the Commissioning Agent shall discuss the issue with the executing Prime Contractor and the commissioning team.

1. When there is no dispute of the deficiency and the associated Prime Contractor accepts responsibility for correcting it, the Commissioning Agent shall document the deficiency, response, and intentions. Corrections of minor deficiencies identified may be made by the associated Prime Contractor during the functional performance testing, at the discretion of the Commissioning Agent. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.

2. When the identified deficiency is corrected, the associated Prime Contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, the Commissioning Agent shall document the deficiency and the associated Prime Contractor’s response, and provide a copy to the Prime Contractor and associated Prime Contractors. Every

attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the Design Engineer. Final acceptance authority shall be The Client Agency.

C. During the functional performance testing of multiple units of similar equipment, the Commissioning Agent will test all of the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (mechanically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the Commissioning Agent. In such case, the Prime Contractor and associated Prime Contractors shall provide the Commissioning Agent with the following:

1. Within one week of notification from the Commissioning Agent, the Prime Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Commissioning Agent within two weeks of the original notice.

2. Within two weeks of the original notification, the associated Prime Contractor shall provide the Commissioning Agent and Department a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.

3. When approved, two examples of the proposed solution shall be installed by the associated Prime Contractor and the Commissioning Agent shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the Commissioning Agent shall

recommend the acceptance or disapproval of the proposed solution to The Client Agency.

4. Upon acceptance of the proposed solution by The Client Agency, the associated Prime Contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.

D. Cost of Retesting

1. The cost for Commissioning Agent personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific pre-functional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the Prime Contractor.

2. For a deficiency identified during the functional testing, not related to any pre-functional checklist or start-up fault, the Commissioning Agent and Client Agency's Rep shall direct the retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the Prime Contractor.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back charges to the responsible party.

3.6 ATC PRIME CONTRACTOR TREND LOGGING REQUIREMENTS

A. The ATC Contractor shall have the ability to trend and graph data at a minimum of 10-points simultaneously for review and analysis. The trends shall be capable of being set up to start sampling all trended points in a given trend or group of trends at exactly the same time.

B. The ATC Contractor shall work with the Commissioning Agent and set up controls system trends for the evaluation and analysis of systems performance requirements.

C. The Commissioning Agent shall work with the ATC Contractor to review specific trending requirements for each system and parameters for trending capabilities.

D. All trends shall be able to be exported to Excel spreadsheet or similar operating systems.

E. The ATC Contractor shall include a detailed description of System Remarks. System Remarks shall include a description of points listing with setpoints, reset schedules and alarming parameters.

F. The System Remarks shall also include a description of the modes of operation and the time bands in which the modes occurred.

G. Trends shall be provided to the Commissioning Agent through normal channels on a CD-Rom for review and graphical representation.

H. The ATC Contractor shall review the trends prior to the submission to the Commissioning Agent for proper operating parameters and completion of systems.

3.7 TRAINING OF USING AGENCY PERSONNEL

A. The HVAC commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The Commissioning Agent shall oversee the content and adequacy of the training of The Client Agency's personnel.

B. The HVAC commissioning supervisor will prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from The Client Agency on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Commissioning Agent for review of the content and adequacy of the training of The Client Agency's personnel for commissioned equipment or systems.

C. Training responsibilities shall include:

1. Provide the Commissioning Agent with training plan one week before the planned training.

2. Provide designated The Client Agency personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing Prime Contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

6. The Prime Contractor shall attend sessions other than the controls training, for each type of equipment controlled by the BAS, to discuss the interaction of the BAS as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

3.8 WRITTEN WORK PRODUCTS

A. Written work products of Prime Contractors listed in these specifications shall consist of the start-up and initial checkout plan and the filled-out start-up, initial checkout and pre-functional checklists.

END OF SECTION 230800

SECTION 230900

FACILITY MANAGEMENT AND CONTROL SYSTEM (FMCS)

PART 1 – GENERAL

1.1 STIPULATIONS

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

B. The automatic temperature controls system shall be Distech Controls. Contact Kyle Gable, Conexus Inc., P: (717)-222-4159

C. “The above item has been approved by the Department as a Proprietary Item. No other item will be accepted. Article 9, Paragraph 9.6, Substitution of Materials, of the General Conditions to the Construction Contract does not apply to the above item.”

1.2 REFERENCES

A. American National Standards Institute (ANSI)
   1. ANSI/ISA 5.5-1985 Graphic Symbols for Process Displays.
   2. ANSI/IEEE 260.1 2004, Standard Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch Pound Units and Certain Other Units).
   3. ANSI/ASHRAE 135-2016, BACnet® - A Data Communication Protocol for Building Automation and Control Networks.

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

A. Acronyms used in BAS.
   1. BAS – Building Automation System
   2. EMCS – Energy Management and Control System
   3. GUI – Graphical User Interface
   4. HVAC - Heating, Ventilation, Air Conditioning
   5. I/O - Input/output
   6. ISA - Industry Standard Architecture
   7. O&M - Operation and Maintenance
   8. Niagara4 – Software framework for building device-to-enterprise applications and Internet-enabled products.
   9. DO – Digital Output

10. DI – Digital Input
11. AO – Analog Output
12. AI – Analog Input

1.4 STANDARDS COMPLIANCE

A. All equipment and material to be from manufacturer's regular production, UL and/or ULC or CSA certified, manufactured to standard quoted plus additional specified requirements.

B. Where UL and/or ULC or CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

C. Additional applicable codes and standards:
1. National Electrical Code -- NFPA 70.
2. Local Electrical Codes
3. Federal Communications Commission -- Part J.

1.5 EXISTING CONTROL COMPONENTS

A. Re-use any existing control wiring and/or piping provided that they conform to applicable codes, standards, and specifications.
1. Sensors may be reused if the new controller supports a minimum 32 point linear interpolation translation table for the sensors.

B. Field control devices that are usable in their original configuration may be re-used provided that they conform to applicable codes, standards, and specifications. Do not modify original design of any existing devices without written permission from Client Agency. Provide for new, properly designed device where components are questionable as to reusability. Provide list of equipment so included in bid. Include unit price of all for this equipment.

C. Within 30 days of award of contract, and prior to installation of any new devices, inspect and test all existing devices intended for re-use. Furnish test report listing each component to be re-used and indicating whether it is in good order or requires repair by Client Agency.

D. Non-functioning items:
1. Provide with report specification sheets or written functional requirements to support findings.

2. Client Agency will repair or replace existing items judged defective yet deemed necessary for BAS.
3. Assume responsibility for items repaired by Client Agency.

E. Submit written request for permission to disconnect any controls and to obtain equipment downtime before proceeding with work.

F. Assume responsibility for existing controls to be incorporated into the BAS and it will commence upon approval for disconnection of controls or equipment downtime.
1. Be responsible for items repaired by Client Agency.
2. Be responsible for repair costs due to negligence or abuse of Client Agency's equipment.
3. Responsibility for existing devices to terminate upon acceptance of the entire BAS system.

G. Remove existing controls not re-used or not required. Place in Client Agency's designated storage. All removed controls will remain the property of the Client Agency.

1.6 WORK INCLUDED

A. Provide a new building system to control and monitor the building's mechanical and electrical systems.

B. Provide control valves, control damper actuators / end switches (gravity, fire and smoke control dampers by others), flow switches, thermal wells for temperature control, air flow stations, and other control devices as necessary.

C. Provide submittal data sheets, control drawings schematics (in Visio or AutoCAD), data entry, electrical installation, programming, start up, test and validation acceptance documentation, as-built documentation, maintenance manuals and system warranties.

D. All labor, material, equipment and services not specifically referred to in this specification or on associated drawings that are required to fulfill the functional intent of this specification shall be provided at no additional cost to the Client Agency.

E. The work covered by this specification and related sections consists of providing submittals, labor, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:

1. Furnish and install all to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.
2. Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
3. Perform acceptance tests as indicated.

1.7 WORK BY OTHERS

A. Setting in place of valves and dampers, access doors, flow meters, water pressure and differential taps, flow switches, thermal wells, air flow stations, and current transformers shall be by others.

B. Duct smoke detectors, smoke dampers, fire/smoke dampers, and associated actuators / end switches shall be provided under another Division of this specification. The Division 26 electrical contractor shall interlock these devices to the BAS for shutdown/monitoring unless otherwise outlined in the Sequences of Operations for this project. The BAS contractor shall coordinate where to land wires and programming as needed.

C. Switches, and power wiring to motors, starters, thermal overload switches, and contactors, is specified under another Division of this specification.

1.8 BAS OPEN SYSTEM DESIGN AND QUALIFICATIONS

A. Open System Design: It is the Client Agency's expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS manufacturer / contractor must provide proof of open system design as outlined below.

B. Prior to award of the contract the BAS contractor is to provide proof of "Open System Design" with the following requirements:
1. Provide proof of having a local office within 50 miles of project for at least 5 years, staffed by trained personnel capable of providing installation, engineering, programming, servicing, instruction, routine maintenance, and emergency service on systems.
2. The controls system shall utilize the Niagara4 software framework.
    a. The Contractor shall have a minimum of 2 years' experience in the sales, installation, engineering, programming, and servicing of Niagara4.

b. Submit the Niagara Compatibility Statement (NiCS) via a letter from the manufacturer. The NiCS shall have no connectivity restrictions and all aspects of the Niagara Framework will be provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties (Station Compatibility In, Station Compatibility Out, Tool Compatibility In, AND Tool Compatibility Out shall each have a value of "All").

3. The controls system shall conform to the following guidelines for communication protocols.
   a. BACnet shall be used for all BAS provided controllers.
      1) The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International and all controllers used shall be BACnet Listed with documentation on the BACnet website (https://www.bacnetinternational.net/btl/search.php)
   b. The use of BACnet Communications protocol alone shall NOT warrant an "Open System Design." Manufacturers must adhere to all aspects of "BAS Open System Design and Qualifications" and "Acceptable System Manufacturers" sections to comply.
      1) Modbus shall only be acceptable for third party devices.
   c. LonTalk shall only be acceptable for sites with existing LonTalk controls architecture where the Client Agency has explicitly stated that the LonTalk architecture must remain in place.
   d. Proprietary communications protocols shall NOT be acceptable.
4. A software programming tool shall be provided for this project and adhere to the following guidelines:
   a. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the Client Agency or his designated agent.
   b. The software programming tool shall be free of charge and openly available for download from the internet.
   c. For any manufacturer that does not have a free programming tool the manufacturer must provide the tool with this project for a minimum of 5 years with proof of availability via letter from the manufacturer.
   d. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SYSTEM MANUFACTURERS AND CONTRACTORS

A. Provide a building automation system supplied by a company regularly engaged in the manufacturing and distribution of building automation systems for a minimum of 5 years.

B. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

C. BACnet/IP communication protocol must be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)

D. Any approved manufacturer that can supply both equipment and controls must provide controls pricing separately from equipment pricing.

E. Acceptable Manufacturers
1. Distech Controls, Installed by Conexus (no exceptions). Contact Brad Himelright, bhimelright@conexus.biz. (717) 222-4158

2.2 QUALITY ASSURANCE

A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:201508 manufacturer, for a minimum duration of 5 years, at time of bid.

2.3 COMPUTER HARDWARE

A. Provide the following computer hardware for this project:
1. Onsite Server(s) [Typical of 1]
2. Workstation Computer(s) [Typical of 1]
3. Uniterruptable Power Supplies

B. Server Hardware Requirements
1. The Server shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 16 GB RAM, and a 1TB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), VM support, and an ethernet adapter (10/100MB with RJ45 connector).Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.

2. The server shall support all network/building controllers, OWSs, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.
3. Acceptable Manufacturers are:
   a. Dell
   b. Lenovo
   c. HP (Hewlett Packard)

C. Workstation Hardware Requirements
1. The Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 8 GB RAM, and a 500GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (10/100MB with RJ45 connector), 32X CD-ROM drive, and 2-USB ports.
2. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 Widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.
3. A mouse and keyboard shall be provided.
4. Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
5. Workstation(s) should be loaded with Programming Tools
6. Acceptable Manufacturers are:
   a. Dell
   b. Lenovo
   c. HP (Hewlett Packard)

D. Uninterruptable Power Supplies
1. Provide the OWS and Server with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration.
2. Acceptable Manufacturer is APC.

2.3 REMOTE ACCESS AND CYBER SECURITY BEST PRACTICES

A. Remote Access
1. The BAS contractor shall comply with Client Agency IT infrastructure security policies for remote access. The Client Agency's IT team shall provide VPN, firewalls, etc. as needed for secure remote access.
2. A VPN and firewall must be used for secure remote access.

B. Cyber Security Best Practices
   1. Unless predetermined by the Client Agency IT team the BAS network shall be separate from the Client Agency's IT infrastructure besides a single point connection for remote access (Client Agency provided internet access). All ethernet switches and communication backbone required for a fully operational BAS shall be provided by the BAS contractor.
   2. Refer to "Communication Backbone" section of this specification for further details on segmenting the network (VLANs, subnets) and when edge or managed switches are required based on building size / type.
   3. Do not use factory provided usernames and passwords. Update passwords and usernames regularly for strong system security.
   4. Update software and firmware regularly.
   5. Adhere to controls manufacturer hardening guidelines where applicable.

2.4 OPERATOR SOFTWARE

A. Real-Time Displays
   1. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
   2. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.

B. On-Line Help
   1. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

C. Security
   1. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.
   2. System security shall be selectable for each operator.
   3. The system administrator shall have the ability to set passwords and security levels for all other operators.
   4. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
   5. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
   6. This auto log-off time shall be set per operator password.
   7. All system security data shall be stored in an encrypted format.

D. System Diagnostics.
   1. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
   2. The failure of any device shall be annunciate to the operator.

E. Third-Party Windows-Based Programs
   1. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
   2. Graphics generation shall be done using standard Windows packages.
   3. No proprietary graphics generation software shall be needed.

F. Overrides
   1. It shall be possible for the operator to override automatic analog and digital output commands.
   2. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command.
   3. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

G. Password Protection
   1. Provide security system that prevents unauthorized use unless operator is logged on.

H. Trend Data
   1. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
      a. Archived files shall be appended with new sample data, allowing samples to be accumulated over 3 years.
      b. Systems that write over archived data shall not be allowed, unless limited file size is specified.
      c. Samples may be viewed at the operator's terminal in a trend log.
      d. Logged data shall be stored in spreadsheet format.
      e. Operator shall be able to scroll through all trend log data.
   2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colours and these Graphs shall show object type value relative to time.
   3. Operator shall be able to change trend log setup information such as time intervals and objects logged

I. Graphics
   1. The operator's workstation shall display all data associated with the project.
      a. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
   2. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
      a. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
      b. All information on any display shall be dynamically updated without any action by the user.
      c. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.
   3. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
   4. Analog objects may also be assigned to an area of a system graphic, where the colour of the defined area would change based on the analog objects value.
      a. For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint.
   5. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
   6. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
   7. Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

J. Alarms
   1. Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.
   2. Any alarm may be handled based on its individual or assigned class actions.
      a. Displayed on the Alarm console.
         1) The system shall be provided with a dedicated alarm window or console.
         2) This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
      b. Alarm reports shall be viewable via the BAS system and available for delivery by electronic mail (e-mail) or printing.

3. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.
    a. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.

K. Scheduling
1. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
2. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
3. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

L. Archiving
1. Store back-up copies of all controller databases in at least one OWS and the server.
2. Provide continuous supervision of integrity of all controller databases.
3. Data base back up and downloading to occur over LAN without operator intervention.
4. Operator to be able to manually download entire controller database or parts thereof.

M. Reports
1. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
2. Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
3. As a minimum, the following reports shall be configured on the system:
    a. Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency.
    b. Summary Report: To permit the display or printing of the dynamic values for the user specified points.
    c. Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.

d. Historical Data Collection: Provision shall be made to ensure historical data is not lost.
e. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
f. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
g. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
h. Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
i. User Record Summary: Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

2.5 BAS CONTROLLERS

A. All controllers on the job shall have the following minimum requirements:
1. IP Communication (BACnet/IP)
a. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
b. Support for IPv4 addressing
c. DHCP support and Auto DNS
d. Baud rate of not less than 100 Mbps
e. - RJ45 ports each capable of supporting 10/100 Base-T.
1) Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
2) Integrated fail-safe should allow for communication when the controller is powered down.
f. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, NAE, etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.
1) Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.

2) The resulting network will be a 'Flat' topology with all devices (controllers, workstations, …) connecting at the same physical network level

2. Memory and Processing
   a. 512KB of RAM and 4GB of non-volatile flash memory.
   b. 32-bit microprocessor operating at a minimum of 600 MHz
3. Each individual controller shall have an embedded web-based HTML5 visual interface with the following functionality without reliance on any other controller for access:
   a. Typical and custom control processes
   b. Scheduling
   c. Energy management applications
   d. Alarm management applications
   e. Historical/trend data for points specified
   f. Maintenance support applications
   g. Graphical interface
4. Shall be capable of monitoring/controlling the following types of inputs/outputs:
   a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
   b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
   c. Digital outputs including Form C relay outputs and Triac outputs
   d. Analog outputs of 4-20 mA, 0-10 Vdc, and 2-10 Vdc.
   e. A minimum of 10% spare capacity for each point type for future point connection.
5. Any software required for programming shall be unlicensed and openly available
6. Auto commissioning features shall be available for VAVs and FCUs to schedule automatic testing and record values (air flows, pressures, temperatures, etc.) for different operating modes. The auto commissioning feature shall be able to email reports and run commissioning on a specified schedule.
7. Power and Environmental Requirements:
   a. 24 VAC with local transformer power
   b. The controllers shall also function normally under ambient conditions of -32 ˚F [0 ˚C] to 122 ˚F [50 ˚C] and 0% to 90% RH (non-condensing).
   c. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
8. Code Compliance:
   a. "FIPS 140-2 Level 1 Compliant" cryptographic module
   b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
   c. UL916 Energy management equipment

d. FCC rules part 15, subpart B, class B
e. UL94-V0 flammability rating

2.6 AUTOMATIC CONTROL DAMPERS

A. Provision of dampers shall be provided by another section of this specification (the BAS contractor shall only be responsible for providing actuators/end switches for control dampers).

2.7 VARIABLE FREQUENCY DRIVES (VFDS)

A. Provision of variable frequency drives shall be provided by another section of this specification (the BAS contractor shall only be responsible for providing associated low voltage wiring and controls programming for the VFDs).

2.8 AUXILIARY CONTROL DEVICES, SENSORS, AND TRANSMITTERS

A. Control Valves
1. High Performance Segmented V-Ball Control Valves:
2. Carbon steel body, hardened stainless steel V-notch ball and shaft, low friction bearings and a TFM 1700 ball seat. Seats and stem packing shall be field replaceable. Control valves shall be rated ANSI Class VI leakage rate, -20 F to 400 F temperature range and maximum 250 PSI allowable shutoff pressure. Globe Valve (valves 2.5” [62.5 mm] to 6” [150 mm]): ANSI Class 125 [250] cast iron body; stainless steel seat, stem and plug; and a TFE V-ring packing. Valves shall be applicable for HVAC temperature control with water, steam, and percentage glycol water mixes. Segmented V-notch ball valves shall have 90 degree rotation, minimum 200:1 range-ability (turn-down), with equal percentage control characteristic.
   a. Sizing:
      1) Modulating: Select valve Cv for acceptable range of control authority with least pressure drop.
      2) Flow Characteristics: Equal percentage characteristics.
      3) Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of operating (inlet) pressure.
      4) Power Requirements: 24 VAC, 24 VDC, or 120VAC as required by manufacturer
3. Hydronic / Zone Control Valves (Modulating Applications):

a. Characterized Control Valve (CCV) (valves 0.5" [12.5 mm] to 2" [50 mm]): Forged brass body, nickel plated rated at no less than 400 PSI and 250 F, stainless steel ball and stem, female NPT union ends, Teflon PTFE seats, and EDPM seat 0-rings, dual EPDM lubricated O-rings at stem and TEFZEL or stainless steel characterizing disc.
b. Sizing:
1) 2-way Modulating: 5 psig [35 kPa]or twice the load pressure drop, whichever is greater.
2) 3-way Modulating: Twice the load pressure drop, but not more than 5 psig [35 kPa].
3) Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for 2-way valves and 125% of the design pressure differential across the 3-way valves.
4) The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory.
5) Power Requirements: 24 VAC or 24VDC

4. Acceptable Manufacturers:
a. Belimo
b. Distech Controls
c. Bray

B. Damper Actuators
1. Features:
a. Electronic Damper Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions, shall utilize v-bolt dual nut clamp with v-shaped tooth cradle coupling, and shall be capable of bing mechanically or electrically paralleled to increase torque if required. Electronic overload protection or digital rotation-sensing circuitry shall be used to prevent any damage to the actuator during a stall condition (and shall not require the use of end switches for protection). Fail-safe operation shall be provided as mechanical spring return (or electrical if spring return is not available for actuator size).
b. Terminal Unit Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions and shall utilize V-bolt dual nut clamp with a V-shaped toothed cradle or an ISO-style direct-coupled mounting pad coupling. Close of differential pressure rating of 200psi.
2. Operating Temperature: -22° F to 122° F (-30° C to 50° C)
3. Protection / Rating: Minimum requirement NEMA type 2 / IP54 mounted in any orientation, NEMA 4X for outdoor applications, and UL94-5V(B) flammability for terminal unit actuators

4. Input/Output:
   a. Two Position: Digital output including Form C relay output
   b. Modulating: 4-20 mA and 0-10 Vdc.
   c. End Switches / Auxiliary Switches (if applicable): SPDT, digital inputs from dry contact closure
5. Power:
   a. Electronic Damper Actuators: Two position spring return shall be 24 or 120VAC as required by manufacturer and proportional actuators shall be 10VA at 24VAC or 8W at 24VDC
   b. Terminal Unit Actuators: maximum of 1 VA at 24VAC or 1 W at 24VDC
6. Agency Approvals:
   a. Electronic Damper Actuators: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.
   b. Terminal Unit Actuators: CE, UL 60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE according to 89/336/EEC.
   c. Approved Manufacturers / Models:
   d. Distech Controls
   e. Belimo

C. Water Differential Pressure Sensor
1. Features: Provide water differential or gage pressure sensors as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range such that it covers from zero differential pressure up to a differential static pressure of 20% to 50% in excess of the maximum static pressure that could be encountered. Remember that if the sensor is used for the control of a chilled water bypass and is located across, for example, a chilled water AHU coil, the pressure drop of both the coil and the associated valve at full design flow have to be taken into account. Sensor shall include over pressure input protection of a minimum two times rated input, burst pressure of a minimum five times rated input, and 17-4PH stainless steel wetted parts.
2. Operating Temperature: -4° F to 185° F (-20° C to 85° C)
3. Protection / Rating: NEMA 4 or NEMA4X if enclosure provided
4. Input/Output: 4-20 mA output proportional to pressure sensed
5. Power: 3-wire circuit for power and output (COM, OUT, EXC) with EXC being 15-30 VDC (18-30 VAC)
6. Accuracy: ± 1% of full scale
7. Range: selectable pressure range 1 – 500 psi
8. Agency Approvals: CE & RoHS Compliant
9. Approved Manufacturer / Model:
   a. Setra (Model 231)
   b. Distech Controls (PS-2LDP Series)

D. Duct / Immersion / Outdoor Temperature Sensors
   1. Features: Provide Thermistor or RTD temperature sensors as indicated within the sequences of operations and/or control diagrams. Install sensor as detailed below.
      a. Outside Air Temperature Sensor: Provide outside air temperature sensors with Aluminum LB with PVC sun and windscreen weatherproof enclosure with conduit entrance. Install in an area where exhaust or roof heat will not affect readings.
      b. Duct Mounted Temperature Sensor (ducts less than 10ft² [1m²] in cross-sectional area): Provide duct mounted, single point probe temperature sensor with 0.25" [6.35 mm] stainless steel probe of length between one-third and two-thirds of the duct width.
      c. Duct Mounted Averaging Temperature Sensor (ducts greater than 10ft² [1m²] in cross-sectional area): Provide duct mounted, averaging, temperature sensor with probe length of 12 feet [3.66m] minimum or 1ft per ft² (3.25m per m²) of duct cross-sectional area, whichever is greater. Copper sheathed or plenum rated flexible construction.
      d. Liquid Temperature Sensor: Provide immersion thermowell mounted temperature sensors for liquid temperature sensing. Rigid 0.25" [6.35mm] stainless steel probe of length, which is, at minimum, 20% of the pipe width. Provide Brass or Stainless steel thermowell (316 or 304) with thermal grease to aid temperature sensing.
      e. Strap-on Temperature Sensor: Provide strap-on mounted temperature sensors where thermo well mounted sensors cannot be mounted.
   2. Operating Temperature: -40° F to 302° F dependent upon application
   3. Input/Output: thermistor or RTD compatible with BAS
   4. Power: dependent upon sensor type – provide as per manufacturers recommendations
   5. Accuracy: ± 0.5°F
   6. Range: -40° F to 302° F dependent upon application
   7. Approved Manufacturer / Model:
      a. ACI (A/AN 10K Type III Series)

E. Space Temperature Sensors
   1. Features: Provide space temperature sensors as indicated within the sequences of operations and/or control diagrams. Shall consist of an element within a ventilated and reinforced protective cover.
   2. Operating Temperature: -40° F to 160° F
   3. Input/Output: dependent upon sensor type – provide as per manufacturers recommendations
   4. Power: dependent upon sensor type – provide as per manufacturers recommendations

5. Accuracy: ± 0.5°F
6. Range: -40° F to 160° F
7. Approved Manufacturer / Model:
   a. ACI (A/AN 10K Type III Series)

F. Low Limit Thermostats
1. Features: Provide low limit thermostats as indicated within the sequences of operations and/or control diagrams. Safety low limit thermostats shall be vapor pressure type with an element 20 ft [6.1 m] minimum length. Element shall respond to the lowest temperature sensed by any one foot section. Low limit shall be manual reset only.
2. Operating Temperature: -60° F to 160° F (-51° C to 71° C)
3. Input/Output: 2 SPDT switches, digital inputs from dry contact closure
4. Power: N/A
5. Accuracy: ± 1.0°F (0.5 °C)
6. Range: adjustable range 15° F to 55° F
7. Approved Manufacturer / Model:
   a. Siemens (Part No. 134-1504)

G. Current Sensor
1. Features: Provide current sensors as indicated within the sequences of operations and/or control diagrams. The current sensors shall be rated for the applicable load and shall be reverse polarity protected and output limited.
2. Operating Temperature: -30° F to 140° F
3. Input/Output:4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw
4. Power: Current sensor shall be self-powered with no insertion loss
5. Accuracy: ± 1% of full scale
6. Approved Manufacturer / Model:
   a. Functional Devices (RIBX- Series)

PART 3 - EXECUTION

3.1 COMMUNICATION BACKBONE

A. To allow for future expandability, cyber security measures, optimal bandwidth, and enhanced data trending this project shall adhere to the below communication backbone requirements.

B. Fiber Optic Network
1. Required for all project exceeding 10 levels (including rooftops/cellars), 100m between ethernet connections, 500 controllers, or more than 1 type of operational technology residing on the same network (CCTV, lighting, access, etc.).

2. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
3. Network edge ethernet switches provided for each floor with provisions for expansion capability.
4. Fiber optic cable shall be run between aggregation switch and edge ethernet switches.
5. Must be a managed fiber / ethernet network with the following network features:
    a. Packet switching and loop detection
    b. Port security with MAC address lockdown and the ability to close all open ports including port connected to a daisy-chain of IP devices.
    c. Segregation / isolation with VLAN configuration capabilities. The system shall allow system-wide auto-creation of a VLAN simply by specifying one or more ports to be on that VLAN, and automatically ensure that traffic passes between the selected ports. There must not be any restriction on port location.
    d. Web browser based graphical user interface for information logging (network overloads, bandwidth consumption, port status, connection status, and trending)
    e. Support both Ethernet and Power over Ethernet (PoE)
    f. Support .fiber optic backbone(s) with Single-strand, Single-mode Optical Fiber OS1/OS2 9/125 μm, up to 12.5 miles [20.1 km] reach
    g. BACnet protocol specific network traffic support and support for all other communication protocols
    h. Expansion capability of up to 256 Edge Ethernet Switches
6. Edge Ethernet Switch Hardware Requirements
    a. Shall provide 1 per floor
    b. Must be compatible with Centralized Ethernet Network Controller with Aggregation Switch and support the managed network features described above
    c. Support Fiber Ethernet, Power over Ethernet (PoE), and Spanning Tree Protocol
    d. Support all communication protocols
    e. Minimum of 8 RJ45 ethernet ports (all controllers on floor must be connected to edge ethernet switch directly or via daisy-chain IP topology)
7. Ethernet Network Controller Hardware Requirements
    a. Shall provide 1 per building
    b. Must be compatible with Edge Ethernet Switches and Aggregation Switch and support the managed network features described above
    c. Support Fiber, Ethernet, Power over Ethernet (PoE), and Spanning Tree Protocol
    d. Support all communication protocols

e. Provide network management software with management of all ports from all edge switches in a single graphical view.

8. Aggregation Switch Hardware Requirements
   a. Shall provide 1 per building
   b. Must be compatible with Edge Ethernet Switches and Aggregation Switch and support the managed network features described above
   c. Support Fiber, Ethernet, Power over Ethernet (PoE), and Spanning Tree Protocol
   d. Support all communication protocols
9. Security Provisions:
   a. Individual VLAN provided per every 2 levels
10. Acceptable Manufacturers for Fiber Network Devices:
    a. Optigo

C. IP (CAT 5 / RJ45) Network
1. Managed Ethernet Switches:
   a. Required for all projects exceeding 5 levels (including rooftops/cellars) or 250 controllers and that do NOT meet or exceed “Fiber Optic Network” requirements described above.
   b. Support for routing and VPN.
   c. Acceptable Manufacturers:
      1) Teltonika
2. Unmanaged Ethernet Switches
   a. Acceptable for all projects NOT exceeding requirements for “Fiber Optic Network” or “Managed Ethernet Switches” as described above
   b. Ethernet Switches shall be provided as needed to support a fully functional BAS – fiber network shall not be required.

D. BACnet IP
1. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)

E. Modbus RTU and BACnet MS/TP (RS-485) Network
1. Modbus RTU and BACnet MS/TP shall only be used for third party systems / equipment that do not have IP provisions (VFDs, boilers, etc.)
2. Modbus TCP shall only be used for third party systems / equipment that do not support BACnet/IP

3.2 INSTALLATION OF SENSORS

A. Install sensors according to manufacturer's recommendations.

B. Mount sensors rigidly and adequately for operating environment.

C. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft.[9 m] of sensing element for each 1 ft^2 [1 m^2] of coil area.

D. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

E. Install outdoor air temperature sensors on north wall at designated location with sun shield.

F. Install building pressure pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.

G. High and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.3 COORDINATION

A. All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer / Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.

3.4 ELECTRICAL WORK, WIRING AND SAFETY

A. Electrical work shall be in accordance ANSI/NFPA 70 and the local Electrical Code.

B. Based on project location, Regional Regulation Compliance Certifications (CSA C22.1) will be required.

C. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.

D. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26 00 00, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.
   1. Power wiring to mechanical equipment, variable air volume boxes, and motor controllers shall be provided by the Electrical contractor (Division 26).
   2. EMT conduit shall be used in mechanical/electrical rooms and exposed spaces.
   3. Rigid Galvanized Steel conduit shall be used outdoors.
   4. Plenum rated cable shall be used in concealed spaces/hung ceilings.

E. All wiring associated with and required by the BAS shall be the responsibility of this contractor.
   1. The term "wiring" shall be construed to include furnishing of wire, conduit, and miscellaneous material and labor as required to install a total working system.
   2. If departures from the contract documents are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings to the Engineer for approval.

F. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.

G. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.

H. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

I. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.

J. Label communication wiring to indicate origination and destination.

K. Fiber optic cable shall comply with the following requirements:
   1. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 µm.
   2. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

3.5 SUBMITTALS

A. Schematic diagram of each controlled system. Label control points with point names.

B. Bill of Material for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.

C. Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc.

D. Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.

E. Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.

F. Riser diagrams showing control network layout, communication protocol, and wire types.

G. Network diagram of control, communication, and power wiring for BAS Server and OWS installation.

3.6 AS-BUILT DOCUMENTATION

A. As-built documentation shall consist of 4 hard copies and one soft copy for all information described below

B. The final documentation package shall include:
   1. As-built Submittals: Final as built control submittals and technical data sheets.
   2. Programming, Sequences, and Graphics: All programming, sequences, and graphics saved to an external hard drive.
   3. Operation and Maintenance Manuals: Factory operating and maintenance manuals with any customization required.
   4. Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures.

3.7 WARRANTY

A. The BAS system labor and materials shall be warranted free from defects for a period of 1 year(s) after final commissioning and Client Agency acceptance.

3.8 TRAINING

A. BAS Contractor shall provide a minimum of 16 hours of training with course outline and materials for personnel designated by the Client Agency.

B. If desired manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the Client Agency or his designated agent. A list of training courses with detailed course outline and duration with the associated cost shall be provided as part of the BAS submittals.

3.9 BALANCING AND COMMISSIONING

A. BAS Contractor shall provide a minimum of 16 hours of commissioning assistance with a commissioning agent and 16 hours of balancing assistance with a balancing agent. Balancing and commissioning agents shall NOT be provided by BAS contractor – BAS contractor is responsible for assistance only.

B. For projects including gas detection / air quality sensors involved in life safety operations a minimum of 8 hours shall be provided within BAS scope of work for the gas sensor manufacturer to provide checkout, calibration, and Client Agency training.

C. Provide commissioning data sheets prior to acceptance testing.

3.10 ALTERNATES

A. Maintenance Contract:
   1. The BAS Contractor shall present a two year maintenance contract for the Client Agency’s acceptance within sixty days after installation of the system begins. Show the price for each year with all payment terms and conditions.
   2. The Maintenance Contract shall include the following provisions: on-line diagnostic and troubleshooting service, quarterly software maintenance/consultation/database backup, repair and replacement as needed (T&M proposals), and emergency service (per predetermined agreement).
   3. Maintenance Routines include, but are not be limited to the following: checking performance of equipment and components (with diagnostic testing, examination, adjustment, and calibration) and 2 training sessions per year.

4. The Maintenance Contract shall be renewable at the Client Agency's option and include provision for increased charges due to expansion of the system, changes in service coverage, and/or inflation.

END OF SECTION 230900

SECTION 230993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 SEQUENCES OF OPERATION (GREEN BUILDING SCOPE OF WORK)

A. Steam to Hot Water Heat Exchanger
   1. General
      a. The BAS shall control the steam-to-hot water heat exchanger system. The BAS shall control and monitor the VFD-driven pumps and differential pressure, control the heat exchanger isolation valves, the steam control valve, and the system bypass valve. The BAS will monitor the supply and return temperatures of the system. The heat exchangers and hot water system pumps shall be operated in a lead/lag fashion through software.

B. Operating/Startup Mode
   1. The steam-to-hot water heat exchanger system shall be enabled whenever an associated air handling or make-up air unit demands heating.
   2. Once enabled, the BAS shall energize the lead exchanger isolation valve. Once the isolation valve has proven open, the BAS shall energize the lead pump. The steam control valve may not operate until system flow has been proven.

C. Pump Control
   1. The BAS shall modulate the speed of the lead pump to maintain differential pressure setpoint (adj.).
   2. In the event the lead pump is running at minimum speed and cannot maintain differential pressure setpoint, the BAS shall modulate the bypass valve as needed to assist in maintaining differential pressure setpoint.

D. Heat Exchanger Temperature Control
   1. The BAS shall monitor the supply temperature (both heat exchangers) and modulate the steam control valve to maintain supply temperature setpoint based on the following reset schedule(adj.):
      a. Supply Temp: 150° F > 110° F
      b. Outside Air Temp: 0° F > 60° F

E. Alarming
   1. An alarm shall be generated at the BAS if a command to a pump VFD been issued and status has not been reported.
   2. An alarm shall be generated at the BAS if a digital input fault has been detected from any pump VFD.
   3. An alarm shall be generated at the BAS if an isolation valve has been signaled to open or close and the respective end switch has not been made.

F. Points List
   1. The BAS shall provide the following points:
      a. Pump VFD Command (DO) (Per pump, wired to VFD)
      b. Pump VFD Speed (AO) (Per pump, wired to VFD)
      c. Pump VFD Status (DI) (Per pump, wired to VFD)
      d. Pump VFD Fault (DI) (Per pump, wired to VFD)
      e. Steam Control Valve (AO)
      f. Heat Exchanger Isolation Valve (AO) (Per heat exchanger)
      g. Heat Exchanger Isolation Valve End Switch (DI) (Per heat exchanger, both open and close)
      h. System Bypass Valve (AO)
      i. System Differential Pressure (AI)
      j. Hot Water Supply Temperature (AI) (Per heat exchanger)
      k. Hot Water Return Temperature (AI)

G. Domestic Hot Water
   1. General
      a. The BAS shall monitor the supply and return temperature of the Steam to Hot Water Domestic Water Heater. The BAS shall monitor status of the DHW pump.
   2. Operating Mode
      a. The DHW pump shall run continuously.
   3. Temperature Monitoring
      a. The BAS shall monitor the supply and return temperature of the water heater. An alarm shall be generated at the BAS if the temperature reaches abnormal levels (adj.).
   4. Points List
      a. The BAS shall provide the following points:
         1) DHW Pump Status (AI) (Per pump)
         2) Water Supply Temperature (AI)
         3) Water Return Temperature (AI)
         4) AHU (Air Handling Unit)

b. General
   1) The unit will function under its own factory programmed sequences. Refer to IOM for specific sequences on heating and cooling control, economizer with dual enthalpy control, and demand control ventilation control.
   2) The BAS shall integrate to the unit's BACnet MS/TP interface.
   3) Through the interface, the BAS shall send the unit an occ/unocc schedule TBD by Client Agency.
   4) The BAS shall have the capability to send the unit heating and cooling setpoints for the occ/unocc modes.
   5) The unit will use the return air duct sensor to reset its discharge air setpoint in either the heating or cooling mode unless overwritten by the BAS.

c. Graphics Display
   1) The BAS shall display the following BACnet points on the graphic.
      a) Occ Mode
      b) Unit Enable
      c) Fan VFD speed
      d) Fan VFD status
      e) Fan VFD fault
      f) Cooling Enabled
      g) # Cooling Stages
      h) Occupied Cooling Setpoint
      i) Unoccupied Cooling Setpoint
      j) Cooling Status
      k) Supply Air Cool Limit Setpoint
      l) Heating Enabled
      m) Heating Status
      n) Staged Heating Command
      o) Constant Volume Occupied Heating Setpoint
      p) Constant Volume Unoccupied Heating Setpoint
      q) Constant Volume Operational Heating Setpoint
      r) Supply Air Heating Limit Setpoint
      s) Economizer Enabled
      t) Economizer Status
      u) Economizer Damper Position
      v) Economizer Minimum Position
      w) Economizer Free Cooling Available
      x) Free Cooling Mode
      y) CO2 Demand Ventilation Mode
      z) CO2 Demand Ventilation Mode IAQ Setpoint

aa) CO2 Demand Ventilation Max Econ Damper Position
bb) CO2 IAQ Range
cc) CO2 Demand Ventilation Differential Setpoint
dd) Supply Air Temperature
ee) Return Air Temperature
ff) Operational Outdoor Temperature
gg) Constant Volume Operating Heating Setpoint
hh) Constant Volume Operating Cooling Setpoint
ii) Operational Space Temperature
jj) Operational Space Temperature Setpoint Offset
kk) Space Temperature Source
ll) Space Temperature Setpoint Offset Range
mm) Space Temperature Offset Source
nn) Space Humidity RAH Input
oo) Outdoor Air Humidity Input
pp) Outdoor Air Enthalpy
qq) Return Air Enthalpy
rr) Net Override Space Temperature
ss) Net Override Outdoor Air temperature
tt) Net Override Indoor Air quality
uu) Net Override Outdoor Air quality
vv) Net Override Outdoor Air Humidity
ww) Net Override Space Humidity
xx) Net Override Space Setpoint Offset

H. MAU (Make-Up Air Unit)
1. General
a. The unit shall be provided with manufacturer controls. The unit consists of a DX cooling section, gas heating section, and an outdoor air damper. The unit controller shall make all determinations related to supply air discharge temperature control. A remote interface (provided by manufacturer) wired to the unit controller will be provided for adjustment of setpoint and other parameters. The BAS shall enable the unit.
2. Operating Mode
a. The BAS shall enable the unit based on a user-defined time schedule. The unit shall run continuously within the appropriate mode.
3. Cooling Control
a. The unit manufacturer controller shall enable and modulate the DX cooling when necessary to maintain supply air discharge setpoint.

4. Heating Control
   a. The unit manufacturer shall enable and modulate the gas heating when necessary to maintain supply air discharge setpoint.
5. Smoke & Freeze Protection
   a. The BAS shall incorporate a hardwired safety circuit, monitoring the smoke detector and freezestat. Upon either device trip, the unit fan shall be shut down. An alarm shall be generated at the BAS. A manual reset at the freezestat shall be required to re-enable the unit.
6. General Alarming
   a. The BAS shall monitor the unit manufacturer controller's general fault contacts. If a digital input is received an alarm shall be generated at the BAS.
7. Points List
   a. The BAS shall provide the following points:
      1) Make-up Air Unit Enable (DO)
      2) Make-up Air Unit Fault (DI)

I. Hot Water Zone Valve Control
1. General
   a. The BAS shall modulate the hot water zone control valve to maintain space temperature setpoint (adj.) upon a call for heating. Each zone shall contain a minimum of two (2) wall mounted space temperature sensors.

J. Operating Mode
1. The BAS shall determine whether the zone is occupied or unoccupied based on a user-defined time schedule.

K. Setpoint Control
1. The BAS shall determine the setpoint (adj.) of each zone based on its operating mode.

L. Hot Water Valve Control
1. Each zone shall contain a minimum of two (2) space temperature sensors. The BAS shall determine an average temperature between all sensors within a zone. The hot water zone control valve shall modulate to maintain setpoint (adj.) in reference to the average temperature.

M. Points List
1. The BAS shall provide the following points:
   a. Space Temperature (AI) (Per zone, qty. 2)
   b. Hot Water Valve Output (AO) (Per zone)

N. Kitchen Exhaust Fan
1. General
a. The BAS shall monitor status of the kitchen hood exhaust fan, which is controlled by a manual switch.

O. Points List
1. The BAS shall provide the following points:
a. Exhaust Fan Status (AI) (Per fan)
b. Mechanical Room Exhaust Fan(s)
2. General
a. The BAS shall monitor the temperature in the mechanical room spaces, and enable the associated exhaust fan. The exhaust fan shall run continuously until the space temperature has fallen below setpoint (adj.).
3. Points List
a. The BAS shall provide the following points:
1) Exhaust Fan Command (DO) (Per fan)
2) Exhaust Fan Status (AI) (Per fan)
3) Space Temperature (AI) (Per mechanical room)

1.2 SEQUENCES OF OPERATION (REED BUILDING SCOPE OF WORK)

A. Steam to Hot Water Heat Exchanger (Qty. 2 Systems)
1. General
a. The BAS shall control the steam-to-hot water heat exchanger system. The BAS shall control and monitor the system pumps and differential pressure, control the heat exchanger isolation valves, the steam control valve, and the system bypass valve. The BAS will monitor the supply and return temperatures of the system. The heat exchangers and hot water system pumps shall be operated in a lead/lag fashion on a time-based (adj.) schedule through software.
2. Operating/Startup Mode
a. The steam-to-hot water heat exchanger system shall be enabled whenever an associated air handling or make-up air unit demands heating.
b. Once enabled, the BAS shall energize the lead exchanger isolation valve. Once the isolation valve has proven open, the BAS shall energize the lead pump. The steam control valve may not operate until system flow has been proven.
3. Pump Control
a. The BAS shall enable the lead pump.
b. The BAS shall modulate the bypass valve as needed to maintain differential pressure setpoint.

4. Heat Exchanger Temperature Control
    a. The BAS shall monitor the supply temperature (both heat exchangers) and modulate the steam control valve to maintain supply temperature setpoint based on the following reset schedule(adj.):
        1) Supply Temp: 150° F > 110° F
        2) Outside Air Temp: 0° F > 60° F
5. Alarming
    b. An alarm shall be generated at the BAS if a command to a pump been issued and status has not been reported.
    c. An alarm shall be generated at the BAS if an isolation valve has been signaled to open or close and the respective end switch has not been made.
6. Points List
    a. The BAS shall provide the following points:
        1) Pump Command (DO) (Per pump)
        2) Pump Status (DI) (Per pump)
        3) Steam Control Valve (AO)
        4) Heat Exchanger Isolation Valve (AO) (Per heat exchanger)
        5) Heat Exchanger Isolation Valve End Switch (DI) (Per heat exchanger, both open and close)
        6) System Bypass Valve (AO)
        7) System Differential Pressure (AI)
        8) Hot Water Supply Temperature (AI) (Per heat exchanger)
        9) Hot Water Return Temperature (AI)

B. MAU (Make-Up Air Unit)
1. General
    a. The BAS shall provide controls for the unit. The unit consists of an outside air section, a face-bypass damper section, supply air section, return air section, and hot water heating coil section. The BAS shall control the unit based on a user-defined (adj.)schedule. The unit shall be controlled to maintain space temperature setpoint (adj.).
2. Operating Modes
    a. The BAS shall enable the unit fan and controls based on a user-defined (adj.) time schedule. The unit shall run continuously within the appropriate mode. The operation of the associated kitchen hood exhaust fan shall also dictate the unit to operate.

3. Occupied
   a. Cooling
      1) The fan shall run continuously. The outside air damper shall open to minimum position. The face-bypass damper shall be in full-bypass position. If the outside air temperature is less than the economizer setpoint, the outside air damper shall modulate to maintain space temperature setpoint. The hot water valve shall be closed.
   b. Heating
      1) The fan shall run continuously. The outside air damper shall open to minimum position. The face-bypass damper and hot water valve shall modulate to maintain space temperature setpoint.
4. Unoccupied
   a. The unit fan shall be commanded off. The outside air damper shall be closed.
5. Kitchen Hood Exhaust Fan
   a. If status is detected on the associated hood exhaust fan, regardless of current operating mode the make-up air unit shall be indexed to occupied mode. The outside air damper shall open fully while the hood exhaust fan is in operation. Upon shutdown of the hood exhaust fan, the outside air damper shall return to its normal schedule and normal Cooling/Heating Mode control parameters.
6. Mixed Air Low Limit & Freeze Protection
   a. The BAS shall incorporate a hardwired safety circuit, monitoring the freezestat. Upon device trip, the unit fan shall be shut down. An alarm shall be generated at the BAS. A manual reset at the freezestat shall be required to re-enable the unit.
   b. In either mode, if the mixed air temperature falls below the low limit setpoint (adj.), the outside air damper shall modulate closed.
7. Alarming
   a. An alarm shall be generated at the BAS if a command to run has been issued and status has not been reported.
8. Points List
   a. The BAS shall provide the following points:
      1) Supply Fan Command (DO)
      2) Supply Fan Status (DI)
      3) Outside Air Damper Actuator (AO)
      4) Face-Bypass Damper Actuator (AO)
      5) Hot Water Valve Output (AO)
      6) Return Air Temperature (AI)
      7) Supply Air Temperature (AI)
      8) Space Temperature (AI)

9) Mixed Air Temperature (AI)
10) Freezestat Status (DI) (Alarm)
11) Outside Air Temp (AI) (Networked Value)

B. Hot Water Zone Valve Control
1. General
a. The BAS shall modulate the hot water zone control valve to maintain space temperature setpoint (adj.) upon a call for heating. Each zone shall contain a minimum of two (2) wall mounted space temperature sensors.
2. Operating Mode
a. The BAS shall determine whether the zone is occupied or unoccupied based on a user-defined time schedule.
3. Setpoint Control
a. The BAS shall determine the setpoint (adj.) of each zone based on its operating mode.
4. Hot Water Valve Control
a. Each zone shall contain a minimum of two (2) space temperature sensors. The BAS shall determine an average temperature between all sensors within a zone. The hot water zone control valve shall modulate to maintain setpoint (adj.) in reference to the average temperature.
5. Points List
a. The BAS shall provide the following points:
1) Space Temperature (AI) (Per zone, qty. 2)
2) Hot Water Valve Output (AO) (Per zone)

C. Mechanical Room Exhaust Fan(s)
1. General
a. The BAS shall monitor the temperature in the mechanical room spaces, and enable the associated exhaust fan. The exhaust fan shall run continuously until the space temperature has fallen below setpoint (adj.).
2. Points List
a. The BAS shall provide the following points:
1) Exhaust Fan Command (DO) (Per fan)
2) Exhaust Fan Status (DI) (Per fan)
3) Space Temperature (AI) (Per mechanical room)

PART 2 -PRODUCTS

Not applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION 230993

SECTION 232113

HYDRONIC PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Heating hot water piping
   2. Condensate-drain piping.
   3. Air-vent piping.
   4. Safety-valve-inlet and -outlet piping.

1.3 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
   1. Heating hot water piping: 125 psig at 200 deg F.
   2. Condensate-Drain piping: 150 deg F.
   3. Air-Vent piping: 200 deg F.
   4. Safety-Valve-Inlet and -Outlet piping: Equal to the pressure of the piping system to which it is attached.

1.4 SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe and fittings.
   2. Pressure-seal fittings.
   3. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   4. Air control devices.
   5. Hydronic specialties.

B. Shop Drawings: Detail, at ¼ scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88, Type M).

B. Wrought-Copper Fittings: ASME B16.22.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. S. P. Fittings; a division of Star Pipe Products.
c. Victaulic Company.
d. Or equal as approved by Professional.

C. Wrought-Copper Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

G. Grooved Mechanical-Joint Fittings and Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. Central Sprinkler Company; a division of Tyco Fire & Building Products.
c. National Fittings, Inc.
d. S. P. Fittings; a division of Star Pipe Products.
e. Victaulic Company.
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2.3 JOINING MATERIALS

A. 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 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:
   a. Hart Industries International, Inc.
   b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   c. Wilkins; a Zurn company.
   d. Or equal as approved by Professional.
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.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Facility Management and Control System (FMCS)".

C. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bell & Gossett Domestic Pump; a division of ITT Industries.
      b. Griswold Controls.
      c. Taco.
      d. Or equal as approved by Professional.
   2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
   3. Ball: Brass or stainless steel.
   4. Stem Seals: EPDM O-rings.
   5. Disc: Glass and carbon-filled PTFE.
   6. Seat: PTFE.
   7. End Connections: Flanged or grooved.
   8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
   9. Handle Style: Lever, with memory stop to retain set position.
   10. CWP Rating: Minimum 125 psig.
   11. Maximum Operating Temperature: 250 deg F.

D. Diaphragm-Operated Safety Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bell & Gossett Domestic Pump; a division of ITT Industries.
      b. Conbraco Industries, Inc.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      d. Or equal as approved by Professional.
   2. Body: Bronze or brass.
   3. Disc: Glass and carbon-filled PTFE.
   4. Seat: Brass.
   5. Stem Seals: EPDM O-rings.
   6. Diaphragm: EPT.
   7. Wetted, Internal Work Parts: Brass and rubber.
   8. Inlet Strainer: removable without system shutdown.
   9. Valve Seat and Stem: Noncorrosive.
   10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amtrol, Inc.
   2. Bell & Gossett Domestic Pump; a division of ITT Industries.
   3. Taco.
   4. Or equal as approved by Professional.

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/8.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 225 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, 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.

B. Stainless-Steel Bellow, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Heating hot water piping, aboveground, NPS 2 and smaller shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Heating hot water piping, NPS 2-1/2 and larger, shall be the following:
   1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.
   3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.

C. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

D. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

E. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 VALVE APPLICATIONS

A. Install shut-off-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each dual-temperature terminal.

3.3 PIPING INSTALLATIONS

A. 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, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blow-off connection for strainers smaller than NPS 2.

T. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Common Work Results for HVAC".

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Common Work Results for HVAC".

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping".

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE 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. 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. The use Pro-press is acceptable.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

3.7 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section "Meters and Gages for HVAC Piping."

3.8 FIELD QUALITY CONTROL

A. 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 hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety 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.

B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. 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, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Set makeup pressure-reducing valves for required system pressure.
   4. Inspect air vents at high points of system 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. Inspect and set operating temperatures of hydronic equipment, such as the boiler, to specified values.
   7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

B. Related Requirements:
1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for expansion fittings and loops.
2. Section 230523 "General Duty Valves for HVAC Piping" for specification and installation requirements for globe valves common to most piping systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:
1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Bell & Gossett; a Xylem brand.
   c. Hays Fluid Controls.
   d. Jenkins Valves; a Crane Co. brand.
   e. Or equal as approved by Professional.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Bell & Gossett; a Xylem brand.
   c. Jenkins Valves; a Crane Co. brand.
   d. Victaulic Company.
   e. WATTS.
   f. Or equal as approved by Professional.
2. Body: Bronze or brass.

3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

C. Diaphragm-Operated Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Bell & Gossett; a Xylem brand.
c. WATTS.
d. Zurn Industries, LLC.
e. Or equal as approved by Professional.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Automatic Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Bell & Gossett; a Xylem brand.
c. Hays Fluid Controls.
d. NIBCO INC.
e. Or equal as approved by Professional.
2. Body: Brass or ferrous metal.

3. Flow Control Assembly, provide either of the following:
   a. Piston and Spring Assembly: Corrosion resistant, tamper proof, self-cleaning, and removable.
   b. Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within 2- to 80-psig differential pressure.
4. Combination Assemblies: Include bonze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as pipe in which installed.
7. Performance: Maintain constant flow within plus or minus 10 percent regardless of system pressure fluctuations.
8. Minimum CWP Rating: 175 psig.
9. Maximum Operating Temperature: 200 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Bell & Gossett; a Xylem brand.
   b. Nexus Valve, Inc.; Aalberts Hydronic Flow Control.
   c. Taco Comfort Solutions.
   d. WATTS.
   e. Or equal as approved by Professional.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Armstrong Fluid Technology.
   b. Bell & Gossett; a Xylem brand.
   c. Taco Comfort Solutions.
   d. WATTS.
   e. Or equal as approved by Professional.

2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

C. In-Line Air Separators:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Armstrong Fluid Technology.
b. Bell & Gossett; a Xylem brand.
c. Taco Comfort Solutions.
d. WATTS.
e. Or equal as approved by Professional
2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Working Pressure: Up to 175 psig.
4. Maximum Operating Temperature: Up to 300 deg F.

2.3 STRAINERS

A. Y-Pattern Strainers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Hays Fluid Controls.
b. Metraflex Company (The).
c. Victaulic Company.
d. WATTS.
e. Or equal as approved by Professional
2. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.

3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
4. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
5. CWP Rating: 125 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Separately coupled, base-mounted, end-suction centrifugal pumps.
   2. Close coupled, inline, centrifugal pumps.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, 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. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

C. Operation and maintenance data.

1.4 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

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 manufacturers specified.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett; Div. of ITT Industries.
   3. Taco, Inc.
   4. Or equal as approved by Professional.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
   5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
   6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, or variable speed (as shown on drawings) with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

H. Capacities and Characteristics: As shown of drawings.

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. Grundfos Pumps Corporation.
4. PACO Pumps.
5. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:
1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and threaded companion-flange or union end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

E. Capacities and Characteristics: As scheduled on drawings.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

PART 3 - EXECUTION

3.1 PUMP INSTALLATION

A. Follow manufacturer’s instructions for pump mounting and start-up.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.2 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill base plate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

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 valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

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."

END OF SECTION 232123

SECTION 232213

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following for LP steam and condensate piping:
   1. Pipe and fittings.
   2. Strainers.
   3. Flash tanks.
   4. Safety valves.
   5. Steam traps.
   6. Thermostatic air vents and vacuum breakers.

1.3 DEFINITIONS

A. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

B. RTRF: Reinforced thermosetting resin (fiberglass) fittings.

C. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
   1. LP Steam Piping: 15 psig.
   2. MP Steam Piping: 50 psig.
   3. HP Steam piping: 100 psig.
   4. Condensate Piping: 100 psig at 250 deg F.

5. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
6. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:
1. RTRP and RTRF with adhesive.
2. Steam trap.
3. Air vent and vacuum breaker.

B. Shop Drawings: Detail, 1/4 inch equals 1 foot scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
1. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify processes and operators according to the following:
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.

D. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings and Unions: ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
1. Material Group: 1.1.
2. End Connections: Butt welding.

3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150-psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 JOINING MATERIALS

A. 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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

F. 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.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Hart Industries, International Inc.
      d. Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group.
      f. Or equal as approved by Professional
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Watts Water Technologies, Inc.
      d. Or equal as approved by Professional
   2. Factory-fabricated companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Central Plastics Company.
      d. Pipeline Seal and Insulator, Inc.
      e. Or equal as approved by Professional
   2. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   3. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure as required to suit system pressures.

2.5 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Stop-Check Valves:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Crane Co.
      b. Jenkins Valves; a Crane Company.
      c. Lunkenheimer Valves.
      d. A.Y. McDonald Mfg. Co.
      e. Or equal as approved by Professional
   2. Body and Bonnet: Malleable iron.
   3. End Connections: Flanged.
   4. Disc: Cylindrical with removable liner and machined seat.
   5. Stem: Brass alloy.
   6. Operator: Outside screw and yoke with cast-iron handwheel.
   7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
   8. Pressure Class: 250.

2.6 STRAINERS

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. Tapped blow-off plug.
   5. CWP Rating: 250-psig working steam pressure.

B. Basket Strainers:
   1. Body: ASTM A 126, Class B cast iron, with bolted cover and bottom drain connection.
   2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
   3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 250-psig working steam pressure.

2.7 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

2.8 SAFETY VALVES

A. Bronze Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Or equal as approved by Professional
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Kunkle Valve; a Tyco International Ltd. Company.
   c. Spirax Sarco, Inc.
   d. Watts Water Technologies, Inc.
   e. Or equal as approved by Professional
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.

4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.9 STEAM TRAPS

A. Float and Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Dunham-Bush, Inc.
   d. Hoffman Specialty; Division of ITT Industries.
   e. Spirax Sarco, Inc.
   f. Sterling.
   g. Or equal as approved by Professional
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig.

B. Inverted Bucket Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Armstrong International, Inc.
   b. Barnes & Jones, Inc.
   c. Dunham-Bush, Inc.
   d. Hoffman Specialty; Division of ITT Industries.

e. Spirax Sarco, Inc.
f. Sterling.
g. Or equal as approved by Professional

2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.10 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International, Inc.
b. Barnes & Jones, Inc.
c. Dunham-Bush, Inc.
d. Hoffman Specialty; Division of ITT Industries.
e. Spirax Sarco, Inc.
f. Sterling.
g. Or equal as approved by Professional
2. Body: Cast iron, bronze or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 300 psig.
7. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International, Inc.
b. Dunham-Bush, Inc.
c. Hoffman Specialty; Division of ITT Industries.
d. Johnson Corporation (The).
e. Spirax Sarco, Inc.
f. Or equal as approved by Professional
2. Body: Cast iron, bronze, or stainless steel.

3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 300 psig.
7. Maximum Temperature Rating: 350 deg F.

2.10 STEAM AND CONDENSATE HEATING PIPING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Armstrong International, Inc.
2. Hoffman Specialty; Divison of ITT Industries.
3. Leslie Controls, Inc.
4. Spence Engineering Company, Inc.
5. Spirax Sarco, Inc.
6. Or equal as approved by Professional

B. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures indicated.

C. Description: Pilot-actuated, diaphragm type, with adjustable pressure range and positive shutoff.

D. Body: Cast iron.

E. End Connections: Threaded connections for valves NPS 2 and smaller and flanged connections for valves NPS 2-1/2 and larger.

F. Trim: Hardened stainless steel.

G. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.

H. Gaskets: Non-asbestos materials.

I. Capacities and Characteristics:
1. Steam Flow Rate: 7500 lb/h.
2. Inlet Pressure: 100 psig.
3. Outlet Set Pressure: 60 psig.

PART 3 - EXECUTION

3.1 HP STEAM PIPING APPLICATIONS (GREATER THAN 15 PSIG)

A. HP Steam Piping, NPS 2 and Smaller: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. HP Steam Piping, NPS 2-1/2 through NPS 12: Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Condensate piping above grade, NPS 2 and smaller, shall be the following:
1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

D. Condensate piping above grade, NPS 2-1/2 and larger, shall be the following:
1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 LP STEAM PIPING APPLICATIONS (LESS THAN OR EQUAL TO 15 PSIG)

A. LP Steam Piping: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

B. Condensate Piping above Grade: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

C. Condensate Piping below Grade: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.3 ANCILLARY PIPING APPLICATIONS

A. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

B. Air-Vent Piping:
1. Inlet: Same as service where installed.
2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

C. Vacuum-Breaker Piping: Outlet, same as service where installed.

D. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.4 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.5 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such 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.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Match size of strainer blow-off connection for strainers smaller than NPS 2.

S. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

T. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
   1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet.

U. Flash Tank:
   1. Pitch condensate piping down toward flash tank.
   2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
   3. Install thermostatic air vent at tank top.
   4. Install safety valve at tank top.

5. Install full-port ball valve, and swing check valve on condensate outlet.
6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
7. Install pressure gage on low-pressure steam outlet according to Division 23 Section "Meters and Gages for HVAC Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors.

W. Install sleeve seals for piping penetrations of concrete walls and slabs.

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.6 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.7 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping."

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.8 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.

C. Install hangers with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

F. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

3.9 PIPE 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 ends. 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. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.10 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

3.11 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," 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 from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

B. Perform the following tests on steam and condensate piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
   3. 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 and repeat hydrostatic test until there are no leaks.

C. Prepare written report of testing.

END OF SECTION 232213

SECTION 232223

STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes electric-driven steam condensate pumps.

1.3 SUBMITTALS

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

B. Shop Drawings: Include details of installation.
   1. Include wiring diagrams.

C. Operation and maintenance data.

1.4 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. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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 manufacturers specified.

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Configuration: Simplex floor-mounting pump with receiver and float switch; rated to pump 200 deg F steam condensate.
   1. Manufacturers:
      a. Pentair Pump Group.
      b. Spence Engineering Company, Inc.; Division of Circor International, Inc.
      c. Spirax Sarco, Inc.
      d. Sterling, Inc.
      e. Or equal as approved by Professional
   2. Receiver: Floor-mounting, close-grained cast iron with externally adjustable float switch(es), and flange(s) for pump mounting.
   3. Pump: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case ring and mechanical seal; mounted on receiver flange.
   4. Factory Wiring: Between pump and float switch, for single external electrical connection. Fused control power transformer if voltage exceeds 230 V.
   5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate if the normal start level for a single pump is exceeded.

B. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 200 deg F steam condensate.
   1. Manufacturers:
      a. Pentair Pump Group.
      b. Spence Engineering Company, Inc.; Division of Circor International, Inc.
      c. Spirax Sarco, Inc.
      d. Sterling, Inc.
      e. Or equal as approved by Professional
   2. Receiver: Floor-mounting, close-grained cast iron, externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.

3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet of NPSH.
5. Control Panel: NEMA 250, Type 1 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
   a. Motor controller for each pump.
   b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
   c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
   d. Momentary contact "TEST" push button on cover for each pump.
   e. Numbered terminal strip.
   f. Disconnect switch.
   g. Fused transformer for control circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

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.

D. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.

E. Install thermometers and pressure gages.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.

C. Pipe drain to nearest floor drain for overflow and drain piping connections.

D. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 232223

SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 185 psig.
   2. Hot-Gas and Liquid Lines: 325 psig.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Field quality-control test reports.

D. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Non-rotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig].

H. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

I. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

J. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in PPM.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 PPM.
5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

K. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 1.5 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

L. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: 1.5 tons.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

PART 3 - EXECUTION

3.1 VALVE AND SPECIALTY APPLICATIONS

A. Install valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at strainers if they are not an integral part of strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.
   3. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

L. Install flexible connectors at compressors.

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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Division 23 Sections “Facility Management and Control System (FMCS)" and "Sequence of Operation for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 8 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

S. Seal pipe penetrations through exterior walls according to Division 7 Section "Joint Sealants" for materials and methods.

T. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.3 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:
   1. Install core in filter dryers after leak test but before evacuation.
   2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
   3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
   4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232500

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Biocide chemical-feed equipment and controls.
   3. Chemical treatment test equipment.
   4. HVAC water-treatment chemicals.

1.3 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including hot-water heating and heat pump loop, shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 PPM.
   3. Boron: Maintain a value within 100 to 200 PPM.
   4. Chemical Oxygen Demand: Maintain a maximum value of 100 PPM.
   5. Soluble Copper: Maintain a maximum value of 0.20 PPM.
   6. TDS: Maintain a maximum value of 10 PPM.
   7. Ammonia: Maintain a maximum value of 20 PPM.

8. Free Caustic Alkalinity: Maintain a maximum value of 20 PPM.
9. Microbiological Limits:
   a. Total Aerobic Plate Count: Maintain a maximum value of 1000 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 0 organisms/ml.
   e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.4 SUBMITTALS

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

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power and control wiring.

C. Field quality-control test reports.

D. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
   2. Water Analysis: Illustrate water quality available at Project site.
   3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

1.5 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.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: The water treatment system shall be furnished and installed by Integritec, Inc. Contact Mr. Dave Lampart, 570-215-0010.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Filter Feeder for Hydronic Heating and Chilled Water Systems: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. 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.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. General
   1. Provide a completely, preassembled package Glycol Feed System as manufactured by Neptune Chemical Pump Company.

B. Pump
   1. The pump shall be a bronze rotary gear pump with a capacity of 1.5 GPM at a pressure of 100 psi. Pump shall be mounted below the tank.

C. Tank
   1. The tank shall be constructed of polyethylene and be provided with a four-let carbon steel stand with four bolt pads. The tank stand shall have upper and lower steel support banding to insure tank stability. Thank stand shall be painted with a two-coat system consisting of an oxide primer and alkyd enamel finish.

D. Piping
   1. Pump suction piping shall be piped using PVC fittings and tubing. A PVC ball valve and a cast iron "Y" strainer shall be provided in the pump suction piping.
   2. Pump discharge manifold shall be piped using Schedule 40 brass fittings suitable for chilled or hot water service. A pressure switch, ball valve, brass check valve and brass relief valve shall be mounted on the pump discharge assembly manifold. Piping shall be supported at both the top and bottom of the tank frame. The brass relief valve shall be piped back to the tank using PVC tubing and fittings. A pressure gauge shall be mounted in the discharge piping.

E. Panel
1. A 115 volt control panel wit NEMA 4X enclosure consisting of the following shall be provided.
a. H-O-A selector switch with running light and magnetic starter for feed pump. In AUTO, the pump is operated by the skid-mounted differential (adjustable) pressure switch and interlocked to a low level float switch mounted in the side of the tank. Level switch also energizes a low level (optional) audible alarm with silence push button for alarm acknowledgement. Panel shall also be equipped with an 8' power cord with grounded plug. Panel shall be mounted to the tank frame and positioned at eye level for ease of operation. Panels mounted on tank lids or mounted below the tank are unacceptable. All electrical components (pressure switch, level switch, and pump) shall be wired in conduit to control panel. Loose, exposed, unprotected wire is unacceptable.

2.4 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
1. Two-station rack for closed-loop systems.
2. Four-station rack for open systems.

2.5 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

2.6 WATER SOFTENERS:
1. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb of salt.
2. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are not acceptable.

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 INSTALLATION

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. Install water testing equipment on wall near water chemical application equipment.

C. Install interconnecting control wiring for chemical treatment controls and sensors.

D. Mount sensors and injectors in piping circuits.

E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and heat pump loop, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install water meter in makeup water supply.
   3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   5. Install a swing check on inlet after the isolation valve.

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 equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

F. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

G. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:
   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 HVAC 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 water 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.

D. Remove and replace malfunctioning units and retest as specified above.

E. Provide monthly field service to monitor control of closed loop system. Included in monthly service shall be a written field report covering work performed and test results.
1. Provide sufficient chemicals for treatment of closed loop systems for a period of one year from substantial completion of system.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 232500

SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Rectangular ducts and fittings.
   2. Round ducts and fittings.
   3. Sheet metal materials.
   4. Sealants and gaskets.
   5. Hangers and supports.

B. Related Sections:
   1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

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

B. Shop Drawings:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Security Cameras
      f. Access panels.
      g. Perimeter moldings.

E. Welding certificates.

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. McGill AirFlow LLC.
      b. SEMCO Incorporated.
      c. Sheet Metal Connectors, Inc.
      d. Or equal as approved by Professional.

B. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
   1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
   2. Tape Width: 3 inches.
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
   10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10-inch w.g., positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

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.
   6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 CFM/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. 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.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
   5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:
   1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 2021. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.7 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:
   1. Ducts Connected to Constant-Volume Air-Handling Units:
      a. Pressure Class: Positive 3-inch w.g.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Return Ducts:
   1. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 3-inch w.g.
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: Negative 1-inch w.g.
      b. Minimum SMACNA Seal Class: C
      c. SMACNA Leakage Class for Rectangular: 24.
      d. SMACNA Leakage Class for Round and Flat Oval: 12.

E. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel.

F. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows" for exhaust ductwork only.
      a. Velocity 1000 fpm or Lower:
         1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
         2) Mitered Type RE 4 without vanes.
      b. Velocity 1000 to 1500 fpm:
         1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
         2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:
1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.
b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical tap or 45-degree lateral.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1000 fpm or Lower: 90-degree tap.
   b. Velocity 1000 to 1500 fpm: Conical tap.
   c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Manual volume dampers.
2. Control dampers.
3. Flange connectors.
4. Turning vanes.
5. Duct-mounted access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

1.3 SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
a. Special fittings.
b. Manual volume damper installations.
c. Control damper installations.
d. Wiring Diagrams: For power, signal, and control wiring.

C. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, and Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. METALAIRE, Inc.
   b. Nailor Industries Inc.
   c. Ruskin Company.
   d. Or equal as approved by Professional.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat-shaped, galvanized-steel channels, 0.064-inch minimum thickness.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Oil-impregnated bronze.
   b. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

2.3 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. METALAIRE, Inc.
   3. Ruskin Company.
   4. Or equal as approved by Professional.

B. Frames:
   1. Hat shaped.
   2. Galvanized-steel channels, 0.064 inch thick.
   3. Mitered and welded corners.

C. Blades:
   1. Multiple blades with maximum blade width of 8 inches.

2. Parallel-blade design.
3. Galvanized steel.
4. 0.064 inch thick.
5. Blade Edging: Closed-cell neoprene edging.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:
1. Oil-impregnated bronze.
2. Dampers in ducts with pressure classes of 3-inch w.g. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.4 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
4. Or equal as approved by Professional.

B. Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. Or equal as approved by Professional.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
   1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single or Double wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.6 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cesco Products; a division of Mestek, Inc.
   2. Ductmate Industries, Inc.
   3. Greenheck Fan Corporation.
   4. Or equal as approved by Professional.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Vision panel.
      d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
      e. Fabricate doors airtight and suitable for duct pressure class.
   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Or equal as approved by Professional.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.8 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
   4. Or equal as approved by Professional.

B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
   1. Pressure Rating: 10-inch w.g. positive and 1.0-inch w.g. negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.

C. Flexible Duct Connectors:
   1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.
   2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream and downstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. At each change in direction and at maximum 50-foot spacing.
   7. Upstream and downstream from turning vanes.
   8. Control devices requiring inspection.
   9. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.
   3. Head and Hand Access: 18 by 10 inches.
   4. Head and Shoulders Access: 21 by 14 inches.
   5. Body Access: 25 by 14 inches.
   6. Body plus Ladder Access: 25 by 17 inches.

I. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

J. Install flexible connectors to connect ducts to equipment.

K. For fans developing static pressures of 5-inch w.g. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

L. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

M. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

N. Connect flexible ducts to metal ducts with draw bands.

O. Install duct test holes where required for testing and balancing purposes.

P. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire 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.

END OF SECTION 233300

SECTION 233423

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Direct drive, backward inclined, centrifugal inline fans.
   2. Direct drive, ceiling mounted, centrifugal exhaust fan.
   3. Belt drive, sidewall mounted, propeller fan.
   4. Direct drive, sidewall mounted, propeller fan.

1.3 SUBMITTALS

A. Provide dimensional drawings and product data on each fan.

B. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.

C. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.

D. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.04 of this specification.

E. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.

F. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.4 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal.

B. Classification for Spark Resistant Construction, levels A, B, and C conform to AMCA 99

C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).

D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

E. The High Wind models have been analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes.

F. Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard.

G. All High Wind models have been analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150MPH) winds over the surface of objects.

H. The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.

C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer

1.6 WARRANTY

A. Manufacturer's Warranty: Submit, for Client Agency's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Client Agency may have under Contract Documents.
   1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from date of substantial completion. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.
   2. Motor Warranty is warranted by the motor manufacturer for a period of one year from date of substantial completion. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

PART 2 - PRODUCTS

2.1 DIRECT DRIVEN BACKWARD INCLINED CENTRIFUGAL INLINE FANS

A. General Description:
   1. Base fan performance at standard conditions (density 0.075 Lb/ft3)
   2. Performance capabilities up to 5,025 cubic feet per minute (cfm) and static pressure to 2.0 inches of water gauge
   3. Fans are available in thirteen sizes with nominal wheel diameters ranging from 8 inches through 16 inches (60 - 160 unit sizes)
   4. Normal operating temperature up to 130 Fahrenheit (54.4 Celsius)
   5. Applications include: intake, exhaust, return, or make-up air systems
   6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel:
   1. Non-overloading, backward inclined centrifugal wheel
   2. Constructed of Aluminum
   3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
   4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone

C. Motors:
   1. Electronically Commutated Motor
      a. Motor enclosure: Open drip proof
      b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors
      c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
      d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor
      e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal
      f. Motor shall be a minimum of 85% efficient at all speeds

D. Housing/Cabinet Construction:
   1. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
   2. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
   3. Aluminum Construction material

E. Housing Supports and Drive Frame:
   1. Housing supports are constructed of structural steel with formed flanges
   2. Drive frame is welded steel which supports the motor

F. Disconnect Switches:
   1. NEMA rated: NEMA 1: indoor application no water. Factory standard.
   2. Positive electrical shut-off
   3. Wired from fan motor to junction box

G. Duct Collars:
   1. Square design to provide a large discharge area
   2. Inlet and discharge collars provide easy duct connection

H. Access Panel:

1. Two sided access panels, permit easy access to all internal components
2. Located perpendicular to the motor mounting panel

I. Options/Accessories:
1. Dampers:
   a. Type: VCD-20, 115 VAC
   b. Galvanized frames with prepunched mounting holes
   c. Balanced for minimal resistance to flow
2. Inlet and Outlet Guards:
   a. Constructed of expanded metal mounted in a steel frame to provide protection for non-ducted installations
3. Motor Cover:
   a. Constructed of galvanized steel
   b. Covers motor and drives for safety
   c. Standard on unit specified with UL

2.2 DIRECT DRIVE, CEILING MOUNTED, CENTRIFUGAL EXHAUST FAN

A. General Description:
1. Base fan performance at standard conditions (density 0.075 Lb/ft3)
2. Ceiling mounted applications
3. Performance capabilities up to 200 cubic feet per minute (cfm) and static pressure to 0.75 inches of water gauge
4. Fans are available in nineteen sizes (50 - 200 unit sizes)
5. Maximum operating temperatures is 130 Fahrenheit (54.4 Celsius)
6. Sound levels as low as 1.7 AMCA sones
7. UL/cUL listed for above bathtub exhaust
8. Fans are UL/cUL listed 507 - Electric Fans
9. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

B. Wheel:
1. Forward curved centrifugal wheel
2. Constructed of calcium carbonate filled polypropylene
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05

C. Motors:
1. Motor enclosures shall be open driproof (ODP), opening in the frame body and or end brackets
2. Motors are permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase

3. Motors shall be mounted on vibration isolators and be accessible for maintenance
4. Compatible for use with speed controls
5. Thermal overload protection

D. Housing:
1. Constructed of heavy gauge galvanized steel
2. Profile as low as 6 15/16 inches

E. Aluminum Backdraft Damper:
1. Prevents air from entering back into the building when fan is off
2. Eliminates rattling or unwanted backdrafts

F. Outlet:
1. Steel duct collar shall be six or four inches in diameter to accept a six or four inch round duct work.
2. Shall include a backdraft damper

G. Grille:
1. Types: Aluminum
2. Constructed of high impact polystyrene plastic shall be factory standard on all units
3. Attached to the housing with screws

H. Mounting Brackets:
1. Fully adjustable for multiple installation conditions

I. Options/Accessories:
1. Disconnect Switches:
a. NEMA rated: 1
b. Positive electrical shut-off
c. Access for wiring shall be external
2. Wall Discharge:
a. Type: Round Connection, hooded wall cap model WC
3. Vibration Kit:
a. Available for suspended installations
b. Includes prepunched hole for ease of installation and shall have all hard-ware to mount one unit.

2.3 BELT DRIVE SIDEWALL MOUNTED PROPELLER FANS

A. General Description:
1. Fan arrangement shall be exhaust.

2. Sidewall mounted applications
3. Performance capabilities up to 54,000 cubic feet per minute (cfm) and static pressure to 3.3 inches of water gauge
4. Fans are available in five sizes with nominal propeller diameters ranging from 24 inches through 48 inches (24 - 48 unit sizes)
5. Maximum continuous operating temperature 130° Fahrenheit with appropriate motor selection.
6. Minimum continuous operating temperature -10° Fahrenheit
7. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual unit serial number
8. Each fan to be supplied with Automatic Belt-Tensioner

B. Propeller:
1. Constructed of: Cast Aluminum
2. Securely attached to motor shaft with a standard square key, set screw and tapered bushing
3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
4. The propeller and fan inlet will be aligned and shall have precise running tolerances for maximum performance and operating efficiency
5. Propellers are not coated when fan coatings accessory is selected regardless of material type

C. Motors:
1. AC Induction Motor
   a. Motor enclosure: Open Drip-Proof
   b. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase
   c. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
   d. Motors can achieve up to 95% efficiency (model and horsepower dependent).

D. Drive Frame:
1. Drive frames and fan panels shall be bolted construction
2. Drive frame assemblies and fan panels shall be galvanized steel or painted steel
3. Drive frame shall be formed steel and fan panels shall have pre-punched mounting holes, formed flanges, and a deep formed venturi

E. Drive Assembly:
1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower
2. Belt: Static free and oil resistant
3. Fully machined cast iron pulleys, keyed and securely attached to the wheel and motor
   shafts

4. The motor pulley shall be adjustable for final system balancing
5. Readily accessible for maintenance

F. Shafts and Bearings:
1. Fan Shaft shall be ground and polished solid steel with an anti-corrosive coating
2. Bearing shall be cast iron pillow block with grease fittings
3. Bearings shall be selected for a minimum L10 life in excess of 100,00 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed
4. Bearing shall be air handling quality and 100% factory tested by bearing manufacturer
5. Fan Shaft first critical speed is at least 25 percent over maximum operating speed

G. Disconnect Switches:
1. NEMA rated: 1
2. Positive electrical shut-off
3. Wired from fan motor to junction box

H. Options/Accessories:
1. Dampers:
   a. Type: Gravity
   b. Prevents outside air from entering back into the building when fan is off
   c. Balanced for minimal resistance to flow
   d. Galvanized frames with pre-punched mounting holes
2. Dampers Guards:
   a. Guard material: Aluminum
   b. Shall completely enclose the damper or wall opening on the discharge side of the fan
3. Finishes:
   a. Types: None
4. Wall Housing:
   a. Mounting arrangement: Flush Exterior
   b. Constructed of galvanized steel or painted steel with heavy gauge mounting flanges and pre-punched mounting holes
   c. Housing shall include OSHA approved motor guard
   d. Reduces installation time and provides maximum installation flexibility
5. Wall Collar:
   a. Constructed of galvanized steel or painted steel with heavy gauge mounting flanges and pre-punched mounting holes
6. Motor Side Guard:
   a. Guard type: OSHA Guard
   b. Protective guard completely enclose the motor and drive side of the fan
7. Propeller Guard:
   a. Guard type: [OSHA Guard]

b. Constructed of coated steel
c. Protective guard completely enclose the propeller side of the fan

2.4 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER FANS

D. General Description:
1. Fan arrangement shall be either exhaust
2. Sidewall mounted applications
3. Performance capabilities up to 7,100 cubic feet per minute (cfm) and static pressure to 0.625 inches of water gauge
4. Fans are available in eight sizes with nominal wheel diameters ranging from 8 inches through 24 inches (8-24 unit sizes)
5. Maximum continuous operating temperature 130 Fahrenheit
6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

E. Propeller:
1. Propeller shall be aluminum blade riveted to steel hub
2. A standard square key and set screw or tapered bushing shall lock the propeller to the motor shaft
3. Statically and dynamically balanced in accordance with AMCA Standard 204-05
4. The propeller and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency

F. Motors:
1. Motor enclosures: Open Drip-Proof
2. Motors are permanently lubricated, sleeve bearing type on sizes 8-12 and ball bearing type on sizes 14-24 to match with the fan load and furnished at the specific voltage and phase
3. Accessible for maintenance

G. Drive Frame:
1. Drive frame assemblies and fan panels shall be galvanized steel
2. Drive frame shall have welded wire or formed channels and fan panels shall have prepunched mounting holes, formed flanges and a deep formed one piece inlet venturi

H. Disconnect Switches:
1. NEMA rated: 1
2. Positive electrical shut-off
3. Wired from fan motor to junction box

I. Options/Accessories:
1. Dampers:
a. Type: Gravity
b. Prevents outside air from entering back into the building when fan is off

c. Balanced for minimal resistance to flow
d. Galvanized frames with pre-punched mounting holes

2. Dampers Guards:
   a. Guard material: Aluminum
   b. Shall completely enclose the damper or wall opening on the discharge side of the fan
3. Finishes:
   a. Types: None
4. Wall Housing:
   a. Mounting arrangement: Flush Interior
   b. Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes
   c. Housing shall include OSHA approved motor guard
   d. Reduces installation time and provides maximum installation flexibility
5. Wall Collar:
   a. Constructed of galvanized steel with heavy gauge mounting flanges and pre-punched mounting holes
6. Motor Side Guard:
   a. Guard type: OSHA Guard
   b. Protective guard completely enclose the motor and drive side of the fan
   c. Coated with Permatector, a thermal setting polyester urethane

2.5 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section "Roof Accessories" for installation of roof curbs.

C. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

D. Install power ventilators level and plumb.

E. Install units with clearances for service and maintenance.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.

7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.
10. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION 233423

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Square ceiling diffusers.
   2. Security diffusers.
   3. Fixed face registers and grilles.
   4. Grid core grille.

B. Related Sections:
   1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Diffusers:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Price Industries.
      c. Titus.
      d. Or equal as approved by Professional.
   2. Devices shall be high performance, high induction, mixing type.
   3. Material: Steel or Aluminum.
   4. Finish: Baked enamel, color selected by Architect.
   5. Face Size: (See schedule).
   6. Mounting: Surface or T-bar. (See Schedule)
   7. Pattern: (See Schedule).
   8. Accessories: (See Schedule)

B. Security Diffusers (Retrofit):
   1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
      a. Kees
      b. Or equal as approved by Professional.
   2. Edge: Square
   3. Material: 1/8” aluminum
   4. Flange: 1”
   5. Finish: White
   6. Offset: ½”
   7. Corner: Radiused
   8. Mounting: Screw holes in flange 10” max o.c. with #10 x 1-1/2” long Torx security button head sheet metal screws.
   9. Pattern: 3/16” holes on 9/32” staggered centers.
   10. Sizing: Matched. Contractor shall field verify each location to receive this style prior to ordering.

2.2 REGISTERS AND GRILLES

A. Fixed Face Register:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Hart & Cooley Inc.
      c. Krueger.
      d. Price Industries.
      e. Titus.
      f. Tuttle & Bailey.
      g. Or equal as approved by Professional.
   2. Material: Steel or Aluminum.
   3. Finish: Baked enamel, color selected by Architect.
   4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid or perforated core.
   5. Core Construction: Integral.
   6. Frame: 1-1/4 inches or 1 inch wide.
   7. Mounting: Lay in or surface (See Schedule).
   8. Accessories: (See Schedule).

B. Grid Core Grille:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Anemostat Products; a Mestek company.
      b. Price Industries.
      c. Titus.
   2. Material: Aluminum.
   3. Finish: Baked enamel, color selected by Architect.
   4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
   5. Mounting: Surface.
   6. Accessory: (See schedule).

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

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 practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235700

HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes shell-and-tube heat exchangers.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Tube-removal space.
   2. Structural members to which heat exchangers will be attached.

1.4 QUALITY ASSURANCE

A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels,".

PART 2 - PRODUCTS

2.1 SHELL-AND-TUBE HEAT EXCHANGERS

A. Available Manufacturers:
   1. Armstrong
   2. ITT Industries; Bell & Gossett.
   3. Taco, Inc.
   4. Or equal as approved by Professional.

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel.

D. Head:
   1. Materials: Cast iron.
   2. Flanged and bolted to shell.

E. Tube:
   1. Seamless copper tubes.
   2. Tube diameter is determined by manufacturer based on service.

F. Tube-sheet Material: Steel.

G. Baffles: Steel.

H. Piping Connections:
   1. Inlet and outlet fluid connections, threaded drain, and vent connections.

I. Support Saddles:
   1. Fabricated of material similar to shell.
   2. Foot-mount with provision for anchoring to support.
   3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

J. Capacity and Characteristics: As shown on drawings.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

3.2 CONNECTIONS

A. Install shutoff valves at heat-exchanger inlet and outlet connections.

B. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

C. Install vacuum breaker at heat-exchanger steam inlet connection.

D. Install hose end valve to drain shell.

END OF SECTION 235700

SECTION 237213

HEAT WHEEL AIR TO AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:

1. Heat wheel air-to-air energy recovery units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For air-to-air energy recovery equipment.

1. Include plans, elevations, sections, details, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE Compliance:

1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2. Capacity ratings for air-to-air energy recovery equipment are to comply with ASHRAE 84, "Method of Testing Air-to-Air Heat/Energy Exchangers."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to drawings and schedules.

2.3 HEAT WHEEL AIR-TO-AIR ENERGY RECOVERY UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Greenheck.
2. Johnson Controls.
3. Or equal as approved by Professional.

2.4 HEAT WHEELS

A. 50 CFM to 280 CFM operational range with 3 high-speed selections

B. Each airstream has an independent centrifugal blower with EC motor and multiple fan speed operations (Assure does not have EC motors)

C. HVI Certified airflow

D. Temperature sensor activated frost prevention. Supply air shuts off to defrost core with warm exhaust air at high speed. Condensation lines are not required

E. Brackets included for easy ceiling install

F. 20-gauge pre-painted galvanized steel construction for superior corrosion resistance, insulated to prevent exterior condensation

2.5 SOURCE QUALITY CONTROL

A. AHRI 1060 Certification: Testing in accordance with AHRI 1060 and listed and labeled by AHRI.

PART 3 - EXECUTION

3.1 INSTALLATION OF HEAT WHEELS

A. Examine roughing-in for electrical services to verify actual locations of connections before installation.

B. Install heat wheels so supply and exhaust airstreams flow in opposite directions and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

C. Install units with clearances for service and maintenance.

D. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts."

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to unit, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Condensate Drain Piping:

1. Pipe drains from drain pans to nearest floor drain; use ASTM B88, Type L, drawn-temper copper water tubing with soldered joints, same size as condensate drain connection.
2. Pipe drains from drain pans to nearest floor drain; use ASTM D1785, Schedule 40 PVC pipe and solvent-welded fittings, same size as condensate drain connection.

E. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate is to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate is to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
4. Set initial temperature and humidity set points.
5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Train Client Agency’s maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237213

SECTION 237313.13

INDOOR, BASIC AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 STIPULATIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTUERS

A. Manufacturers: Subject to strict compliance with the requirements of this specification, provide products by one of the following:
   1. Air Handling Units:
      a. Johnson Controls/York.
      b. Trane.
      c. Daikin.
      d. Or equal as approved by Professional.

2.2 INDOOR UNIT

A. Instrumentation and Control Devices for HVAC
   1. Sensors and Transmitters
      a. Thermostats
         1) Unit shall operate with conventional thermostat designs and have a low voltage terminal strip for easy hook-up.

B. Electric and Electronic Control System for HVAC
   1. Indoor Units
      a. General
         1) Unit shall utilize color- coded wiring.
         2) Unit shall be factory wired with self-contained low-voltage control circuit protected by a resettable circuit breaker on the 24-volt transformer side.
         3) Unit shall operate with conventional thermostat designs and have a low voltage terminal strip for easy hook-up.
      b. Safeties

1) Heating section shall be provided with the following minimum protections:
   a) High temperature limit switches.

2. Indoor Split System Units
   a. General
      1) Factory-wired, piped, and tested for leakage and functionality to assure trouble-free installation and startup.
      2) Blower motor and VFD, shall be subjected to a completely run test on the assembly line. The data for each unit will be stored at the factory and must be available upon request.
      3) The products have been tested and approved by CSA under UL 1995 and performance certified under ARI 340/360 Unitary Large AC and Heat Pumps when matched with compatible Ducted Systems outdoor units.
      4) Unit shall use environmentally sound, R-410A refrigerant.
      5) Covered by a 1-year limited parts warranty.
      6) Unit shall be installed in accordance with the manufacturer's instructions.
      7) Unit must be selected and installed in compliance with local, state, and federal codes.
3. Quality Assurance
   a. Unit meets ASHRAE 90.1 minimum efficiency requirements when pairedwith factory provided outdoor condensing unit.
   b. Unit shall be rated in accordance with AHRI Standards 340/360.
   c. Unit shall be designed to conform to ASHRAE 15
   d. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
   e. Unit casing shall be capable of withstanding 750- hour salt spray exposure per ASTM B117 (scribed specimen).
   f. Unit shall be subjected to a completely automated run test on the assembly line. The data for each unit will be stored at the factory and must be available upon request.
   g. Unit shall be designed in accordance with UL Standard 1995, including tested to withstand rain.
4. Delivery, Storage, and Handling
   a. Unit shall be stored and handled per manufacturer's recommendations.
   b. Install each unit as shown on the plans in accordance with the manufacturer's recommendations and all applicable national and local codes.
5. Project Conditions
   a. As specified in the contract.
6. Operating Characteristics

a. Outdoor and indoor units shall be rated at maximum load criteria under ARI Standard 340/360. Indoor unit shall have the ability to produce airflow as published in technical literature.
b. Indoor unit should have ability to operate with factory matched Condensing Unit or Heat Pump without factory or field modifications.
c. Unit shall discharge air vertically or horizontally.

7. Electrical Requirements
   a. Main power supply voltage, phase, and frequency must match those required by the manufacturer.
   b. Single-point connection electrical power.
   c. Nominal unit electrical characteristics are 208v, 3ph, 60 Hz. The unit is capable of satisfactory operation within voltage limits of ____ v to _____ v. Main power supply voltage, phase, and frequency must match those required by the manufacturer.
   d. Shall utilize color- coded wiring.

C. Unit Cabinet
1. Cabinet shall be constructed of 18 gauge, zinc coated steel, finished with a powder paint process capable of withstanding a minimum of 750 salt spray hours according to ASTM B117.
2. Interior cabinet surfaces shall be insulated with a minimum ½ in. thick, foil faced fiber glass insulation with thermal conductivity of 0.24 or better, adhered with acrylate polymer based adhesive.
3. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
4. The units must have the ability for field conversion and application in eight vertical or horizontal positions.
5. The indoor units must be field convertible by moving the position of the blower section. The unit must have the ability to accept return air from the unit's front or bottom.
6. Units may be bottom-supported or ceiling-suspended.
7. Cabinet shall feature a separate access panel for controls and air filters so that unit airflow need not be disturbed during servicing.
8. Removable panels shall be provided for easy access to the internal components for maintenance and service.
9. Indoor units must have a filter rack that accepts both 2 in. and 4 in. (7.5-20 Ton) filters. 2 in. throwaway filters shall be provided as standard.
10. The units shall ship with a nitrogen holding charge.

D. Coils
1. Indoor Coils:

a. Evaporator coil shall be direct expansion, draw through design.
b. Consist of copper tubes arranged in staggered rows, mechanically expanded into aluminum fins.
c. Include factory-mounted distributors, adjustable thermal expansion valves and solenoid valves for both capacity reduction and refrigerant pump out on start-up.
d. Include factory installed auxiliary side connectors for the addition of field installed hot gas bypass without altering the units TXV or refrigerant distributor.
e. Unit shall include filter/strainer to eliminate any foreign matter.
f. Evaporator coil is leak tested and pressure tested to 450 psig.

2. Optional E-Coat indoor coils:
a. Evaporator coils shall be protected by the E-Coat 10-1 four coat process. Coils are dipped in a phenolic coating, that provides substantial resistance to corrosion of aluminum and copper.
b. Corrosion durability shall be confirmed through testing to exceed 6000 hours salt spray per ASTM B117- 97.

E. Refrigerant Circuits
1. Indoor units from 10 to 20 tons are available in either two or four pipe configurations. 7.5 and 25 ton units are in two pipe configurations. Each circuit is provided with a dedicated expansion valve.
2. Refrigerant circuit shall include the following control, safety, and maintenance features:
a. Thermostatic Expansion Valve (TXV) shall help provide optimum performance across the entire operating range. Shall contain removable power element to allow change out of power element and bulb without removing the valve body.

F. Indoor fan, Motors and VFD
1. Indoor fan
a. Fan shall be a V-belt drive assembly and include an adjustable pitch motor pulley, that will permit the blower RPM to be adjusted to meet the CFM requirements.
b. Dual fans mounted on a single shaft shall be provided on 20 and 25 ton units.
c. Fan wheel shall be double-inlet type with forward-curved blades, dynamically balanced to operate smoothly throughout the entire range of operation and minimize sound and vibration levels.
2. Fan motor
a. The blower motor shall be mounted within the insulated cabinet to mini-

mize the transmission of sound to the surrounding space, and any motor 7.5 HP or greater must have a service factor of 1.15

b. All motors shall be UL approved, with permanently lubricated ball bearings and an automatic reset, motor thermal overload protector.

c. Optional high static HP motors shall be made available for each unit to meet different static requirements.

3. IntelliSpeed (SZVAV) discrete fan control (7.5 - 20 ton systems) shall have:
   a. Control fan speed with a VFD (Variable Frequency Drive)
   b. Drive fan speed based on the number of cooling or heating stages.
   c. Maximum airflow on first stage cooling not to exceed 67%.
4. Variable Frequency Drive (VFD). (Included with IntelliSpeed (SZVAV) for 7.5 - 20 ton systems)
   a. Shall be installed inside the unit cabinet, mounted, wired and tested.
   b. Shall contain Electromagnetic Interference (EMI) frequency protection.
   c. Insulated Gate Bi- Polar Transistors (IGBT) used to produce the output pulse width modulated (PWM) waveform.
   d. Built in LED display and controls. Does not require additional kit or options.
   e. RS485 capability standard.
   f. Electronic thermal overload protection.
   g. All printed circuit boards shall be conformal coated.
   h. A customer installed VFD option shall also be available.
5. Factory-installed manual bypass switch option shall be available to bypass the drive and operate the motor at full speed, or to power the drive (and not the motor) for diagnostic purposes.

G. Special Features Options and Accessories
   1. Mixing box / Economizer
      a. A fully insulated, factory assembled, CA Title 24 compliant mixing box with galvanized steel construction and direct coupled actuator may be provided for outside air requirements.
      b. Mixing box must meet leakage rates required by ASHRAE 90.1 and provide AMCA certified CD-60 airfoil dampers and blades.
      c. Optional modulating controls with selectable dry bulb or enthalpy sensing capability shall be provided.
   2. Hot water coils
      a. The hot water coil accessory shall be provided in a galvanized steel casing with two rows, 12 Fins per inch and 1/2 in. OD copper tube.
      b. Drain-able hot water coils shall be available for field installation between the blower and the coil modules of both horizontal and vertical units. Coils shall have copper tubes that have been mechanically ex-

panded into aluminum fins. Both headers shall be located on the same end of the coil.

c. Valves to be furnished by the installer.

3. Base sections (Only up to 20 Tons)
   a. The modular design of the base section allows quick, easy installation under the evaporator section of the indoor unit models listed.
   b. Finished to match the unit exterior, base accessory shall raise the indoor units 10" above the floor.

2.3 CONTROLS

A. Instrumentation and Control Devices for HVAC
   1. Sensors and Transmitters
   2. Thermostats
      a. Thermostat must
         1) Energize “Y” when calling for cooling and “W” when calling for heating.
         2) Standard Efficiency AC units, shall have the capability to energize 2 different stages of cooling, and 2 different stages of heating.
         3) For High Efficiency AC units, shall have the capability to energize 2 different stages of cooling and 2 different stages of heating.
         4) Shall include capability for occupancy scheduling.

B. Direct- Digital Control System for HVAC
   1. Decentralized, Outdoor Condensing Units:

      SMART Equipment Control
      a. Shall be ASHRAE 62 compliant.
      b. Shall accept 20-30 VAC input power, 50/60Hz. 24 VAC nominal.
      c. Shall have an ambient operating temperature range from 40°F to 125°F; with a storage temperature range from -40°F to 194°F; 5-95% RH (non-condensing). Unit can operate at 0°F if low ambient kit is installed.
      d. Controller shall accept the following inputs: space temperature, set point adjustment, return air temperature sensor, outdoor air temperature, indoor relative humidity, compressor lock- out, fire/smoke shutdown, fan status, remote time clock, Sensor Actuator (SA) Bus communicated temperature/humidity from Network sensors, Field Controller (FC) Bus Network Overrides for space temperature, outdoor air temperature, space humidity.
      e. Shall provide compressor short-cycle protection with minimum compressor runtime set at 5 minutes standard and adjustable from 3 to 10 minutes.

f. Built in lead-lag compressor sequencing to support balanced utilization of refrigerant circuits.
g. Shall provide the following outputs: fan, VFD, cooling stage 1, cooling stage 2, heat stage 1, heat stage 2 , reversing valve, occupied.
h. Unit shall provide surge protection for the controller through a circuit breaker.
i. Shall have open communication protocols with all required points exposed. Protocols supported include: BACnet® MS/TP, Modbus®, and N2 communication.
j. Shall have an LCD display on the Unit Control Board to display fault messages as well as navigate the menu structure to review and change set points.
k. Shall utilize a USB connection to allow for uploading and downloading of data.
l. USB shall allow for downloading of "trending data" for analysis of inputs and values on other device such as a PC.
m. USB shall allow for uploading of new firmware to the UCB.
n. USB shall allow for backing up controller set points and parameters and for uploading of these same parameters to the UCB.
o. Unit shall be compatible with a MAP device, that shall include ability to view and change all adjustable parameters and set points using the same characteristics and values available directly through the UCB joystick and LCD display.
p. Shall have the capability to integrate with the Verasys® zoning system.
q. Shall not require any proprietary software or contractor tool to start-up, commission and troubleshoot unit operation.
r. Software upgrades will be accomplished by local download via USB port on main Unit Control Board.
s. Shall be UL Recognized, File E107041, UL 916, Energy management Equipment, UL 1995, Heating and Cooling Equipment; FCC Compliant to CFR47, Part 15, Subpart B, Class B, CSA 22.2 No. 236, Signal Equipment Industry Canada, ICES-003 Recognized, and BTL certified.

C. Electric and Electronic Control System for HVAC
1. Decentralized, Outdoor Condensing Units:
General:
a. Shall be complete with self- contained low- voltage control circuit protected by a resettable circuit breaker on the 24- v transformer side. Transformer shall have 150VA capability.
b. Shall utilize color- coded wiring.
c. Shall include a central control terminal board to conveniently and safely

provide connection points for vital control functions such as: smoke detectors, phase monitor, gas controller, economizer, thermostat, DDC control options, and low and high pressure switches.

D. Safeties:
1. Compressor over- temperature, over- current. High internal pressure differential.
2. Low pressure switch and high-pressure switch

2.4 OUTDOOR SPLIT SYSTEM CONDENSING UNITS

A. General
1. Outdoor, rooftop or slab mounted, electrically controlled, heating and cooling unit utilizing a fully hermetic, suction gas cooled, direct drive compressor(s) for cooling duty or heat pump duty (up through 20 tons).
2. Factory assembled, single- piece outdoor condensing unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and special features required prior to field start- up.
3. Unit shall use environmentally sound, R-410A refrigerant.
4. Unit shall be installed in accordance with the manufacturer's instructions.
5. Unit must be selected and installed in compliance with local, state, and federal codes.
6. Unit shall have one year limited parts warranty on complete unit with an additional four year compressor parts warranty.

B. Quality Assurance
1. Unit meets ASHRAE 90.1-2019 minimum efficiency requirements when matched with a factory provided indoor unit.
2. Unit shall be rated in accordance with AHRI Standards 340/360 (complete matched system).
3. Cooling performance rated in accordance with DOE and AHRI test procedures.
4. Unit shall be designed to conform to ASHRAE 15
5. Unit shall be UL- tested and certified in accordance with ANSI Z21.47 - 2012/CSA 2.3-2012, CSA C22.2 No. 236-11 (UL 1995) 4th edition and CSA C22.2 No. 3 - M 1988.
6. Insulation and adhesive shall meet NFPA 90A requirements for flame spread and smoke generation.
7. Unit casing shall be capable of withstanding 750- hour salt spray exposure per ASTM B117 (scribed specimen).
8. Unit shall be subjected to a completely automated run test on the assembly line.

The data for each unit will be stored at the factory and must be available upon request.

9. Unit shall be designed in accordance with UL Standard 60335, including tested to withstand rain.
10. Unit shall be constructed to prevent intrusion of snow and tested to prevent snow intrusion into the control box
11. Unit shake tested to Truck 2, ASTM D4169 to ensure shipping reliability.

C. Delivery, Storage, and Handling
   1. Unit shall be stored and handled per manufacturer's recommendations.
   2. Overhead crane can be used to place the units on a roof using rigging holes built into the unit base rails without any additions to the unit.
   3. Unit shall only be stored or positioned in the upright position.

D. Project Conditions
   1. As specified in the contract.
   2. Operating Characteristics
      a. Unit shall be capable of starting and running at 125°F (52°C) ambient outdoor temperature, meeting maximum load criteria of AHRI Standard 340/360 at ±10% voltage.
      b. Compressor with standard controls shall be capable of operation down to 40°F (4.4°C), ambient outdoor temperatures. Optional low ambient kit is available if mechanically cooling at ambient temperatures below 40°F (4.4°C).
      c. Unit shall discharge condensing air vertically.
   3. Electrical Requirements
      a. Main power supply voltage, phase, and frequency must match those required by the manufacturer.
   4. Unit Cabinet
      a. Unit cabinet shall be constructed of galvanized steel with exterior surfaces coated with a non-chalking, powder paint finish, certified at 750 hour salt spray test per ASTM-B117 standards.
      b. Unit cabinet shall have knockouts in the side of the unit for refrigerant piping and wiring connections.
      c. Base Rail
         1) Unit shall have base rails on a minimum of 4 sides.
         2) Base rail mounted lifting lugs shall be provided in the base rails for rigging shackles to facilitate maneuvering and overhead rigging.
         3) Base rail shall be a minimum of 15-gauge thickness.

d. Top panel:
a. Shall be a multi piece top panel. (7.5-12.5TR single piece, 15-25TR multi piece)
e. Electrical Connections
1) All unit power wiring shall enter unit cabinet at a single, factory prepared, and knockout location.
2) Through- the- base capability.
a) Standard unit shall have a through- the- base electrical location(s) using a raised, embossed portion of the unit base-pan.

b) Optional, factory approved, water- tight connection method must be used for through- the- base electrical connections.
c) No base-pan penetration, other than those authorized by the manufacturer, is permitted.
f. Units shall meet the wind load requirements under Florida Building Code 2020 as per ASCE 7-16.
1) Units are certified with wind resistance ratings of 186 MPH as certified by independent structural engineers.
g. The units shall ship with a nitrogen holding charge.

2.5 COILS

A. Outdoor Coils:
1. Standard condensing units shall be constructed with Microchannel aluminum fins and aluminum tubing.
2. Standard heat pumps shall have aluminum plate fins mechanically bonded to seamless internally grooved copper tubes with all joints brazed.
3. Shall be leak tested to 150 psig, pressure tested to 250 psig, and qualified to CSA C22.2 No. 236-11(UL 1995) 4th edition burst test at 1775 psig.
4. Assembled unit shall be pressure tested to 450 psig.

B. E-Coat condenser coils (**shall be provided outdoor condensing units**):
1. Shall have a flexible epoxy polymer coating uniformly applied to all coil surface areas without material bridging between fins.
2. Coating process shall ensure complete coil encapsulation of tubes, fins and headers.
3. Humidity and water immersion resistance shall be a minimum of 1000 hours (ASTM D2247- 99 and ASTM D870- 02).
4. Corrosion durability shall be confirmed through testing to exceed 6000 hours salt spray per ASTM B117- 97.

2.6 REFRIGERANT CIRCUITS

A. Outdoor units from 10 to 20 tons are available in either two or four pipe configurations. 7.5 and 25 ton units are in two pipe configurations. Refrigerant circuit shall include the following control, safety, and maintenance features:
   1. Solid core refrigerant filter driers shall be shipped loose for field installation.
   2. Service gauge connections on suction and discharge lines shall be provided for ease of service.
   3. Suction and discharge line service ports should be accessible from the unit. Ports must be capped for leak prevention.
   4. Magnetic check valves shall be provided on the liquid line.

B. Compressors
   1. Unit shall use fully hermetic scroll compressors for each independent refrigeration circuit.
   2. Compressor motors shall be cooled by refrigerant gas passing through motor windings.
   3. Compressors shall be internally protected from high discharge temperature conditions.
   4. Compressors shall be protected from an over- temperature and over- amperage conditions by an internal, motor overload device.
   5. Compressor shall be factory mounted on rubber grommets.
   6. Compressor motors shall have internal line break thermal, current overload and high pressure differential protection.
   7. Crankcase heaters shall be installed in the factory for all necessary applications.
   8. Compressors shall have a full charge of compressor oil.

2.7 CONDENSER FANS AND MOTORS

A. Condenser fan motors:
   1. Shall be a totally enclosed motor.
   2. Shall use permanently lubricated ball-bearings.
   3. Shall have inherent thermal overload protection with an automatic reset feature.
   4. Shall use a shaft- up design.

B. Condenser Fans:
   1. Shall be a direct- driven propeller type fan.
   2. Shall have aluminum blades riveted to corrosion- resistant steel spider brackets and be dynamically balanced.
   3. Shall be equipped with PVC coated steel wire safety guards.
   4. Shall be arranged for vertical air discharge.

2.8 SPECIAL FEATURES OPTIONS AND ACCESSORIES

A. Hot gas bypass

A discharge bypass valve (DBV) kit shall be provided to meter the compressor discharge gas to a system's evaporator coil during low load operation.

The valve may be installed in either a horizontal or vertical orientation.

Unit shall have a discharge line stub-out to allow for hot gas bypass line connections.

B. Hail Guard
1. Shall protect against damage from hail.
2. External sloped hood style.

C. Non- Fused Disconnect Switch (Coordinate with .4 Contractor):
1. Switch shall be factory installed, internally mounted.
2. National Electric Code (NEC) and UL approved non- fused switch shall provide unit power shutoff.
3. Shall be accessible from outside the unit.
4. Shall provide local shutdown and lockout capability.

D. Convenience Outlet:
1. Powered convenience outlet (Coordinate with .4 Contractor).
    a. Outlet shall be powered from main line power to the condensing unit.
    b. Outlet shall be factory installed and internally mounted with easily accessible 115- v female receptacle.
    c. Outlet shall include 20 amp GFI receptacles with independent fuse protection.
    d. Voltage required to operate convenience outlet shall be provided by a factory installed step- down transformer.
    e. Outlet shall be accessible from outside the unit.

E. Low Ambient Kit
1. Shall contain an integrated low ambient controller to regulate condenser head pressure at low ambient temperatures by varying the amount of airflow through the condenser.
2. Shall allow units to operate in cooling mode down to 0° F outdoor ambient.
3. Shall be required when mechanical cooling is required at temperatures below 40° F

PART 3- EXECUTION

1.2 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

1.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:
1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

C. Air-handling unit and components will be considered defective if unit or components do not pass tests and inspections.

D. Prepare test and inspection reports.

1.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Client Agency’s maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.13

SECTION 237433

DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This section includes units with integral heating and cooling for outdoor installation. Integral heat source shall be hot water. Integral cooling source shall be packaged DX. Airflow arrangement shall be Outdoor Air with Recirculation. Each unit shall incorporate additional product requirements as listed in Section 2 of this specification.

B. Related Sections include the following:

1. Section 22 00 00: Scope of Work
2. Section 22 01 00: General Provisions
3. Section 22 07 00: Insulation
4. Section 22 10 00: Plumbing
5. Section 23 09 00: Controls and Instrumentation
6. Section 23 00 00: Electrical

1.3 SUBMITTALS

A. Product Data: For each type or model include the following:

1. Complete fan performance curves for both Supply Air and Exhaust Air, with system operating conditions indicated, as tested in an AMCA certified chamber.
2. Sound performance data for both Supply Air and Exhaust Air, as tested in an AMCA certified chamber.
3. Motor ratings, electrical characteristics and motor and fan accessories.
4. Performance ratings for all chilled water or DX coils.
5. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
6. Estimated gross weight of each installed unit.

7. Installation, Operating and Maintenance manual (IOM) for each model.
8. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.

B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.

C. Product Options: Drawings must indicate size, profiles and dimensional requirements of unit and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".

D. End of line test with full report available upon request.

E. Certifications

1. Entire unit shall be ETL Certified per U.L. 1995 or U.L. 60335-2-40 and bear an ETL sticker.
2. Coils shall be Recognized Components for ANSI/UL 1995, CAN / CSA C22.2 No 236.05.

1.5 COORDINATION

A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.

B. Coordinate location of water system fittings to ensure correct positioning for connection to the water coil and condensate drain pipe.

C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply, roofing contractor.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:

1. Greenheck Fan Corporation
2. Or equal as approved by Professional

2.2. MANUFACTURED UNITS

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, downturn outdoor air intake with 2" aluminum mesh filter assembly, evaporator coil, hot water coil, hot gas reheat coil, packaged DX system, phase and brownout protection, motorized dampers, motorized recirculating damper, curb assembly, filter assembly intake air, supply air blower assembly, and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power.

2.3. CABINET

A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
   1. Unit's exterior shall be supplied from the manufacturer using G60 galvaneal steel with proprietary pre-painted material in the following finish color; Concrete Gray-RAL 7023. This has been subjected to a salt spray test per ASTM-B117 and evaluated using ASTM-D714 and ASTM-D610 showing no observable signs of rust or blistering until reaching 2,500 hours. Uncoated galvanized steel exterior is not acceptable.
   2. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.

B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
   1. Materials: Rigid urethane injected foam. Foam board not acceptable.
      a. Thickness: 2 inch (50.8 mm)
      b. Thermal Resistance R13
      c. Thermally broken
      d. Meets UL94HF-1 flame requirements.
      e. Location and application: Full coverage of entire cabinet exterior to include walls, roof of unit, unit base, and doors.
   2. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
      a. Thickness: 2 inch (50.8 mm)
      b. Thermal Resistance R8
      c. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.

d. Location and application: Divider panels between outdoor air and return air/exhaust air streams.

C. Roof Insulation: 2 inch (50.8 mm) fiberglass located above the 1 inch (25.4 mm) foam panel.

D. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel or painted galvannealed steel.

E. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fans. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motors shall be capable of continuous speed modulation and controlled by a VFD.

F. Evaporator Coil: Evaporator coil shall be (silver) soldered or brazed into the compressed refrigerant system. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame. If two compressors are used as components of the unit, then the evaporator coil shall be of "interlaced" configuration, permitting independent operation of either compressor without conflict with the other compressor.

G. Control panel / connections: Units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch.

H. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.

I. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.

J. Reheat coil with factory installed modulating hot gas reheat valve.

K. Packaged DX System: Unit shall have an integral compressor(s) and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Lead condenser fan shall have EC motor to maintain condenser pressure at part load conditions. Motors shall be UL Recognized and CSA Certified. The lead refrigerant compressor(s) shall be inverter hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion

valves (TXV)(s), manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Compressors shall be mounted within an insulated access compartment and on a raised cabinet shelf to reduce sound and vibration. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil.

L. Condenser Fans: Fan blades must be constructed of aluminum or a composite material and have a geometry designed and documented to reduce sound and energy when compared to a traditional rectangular blade fan. Traditional rectangular blade fans are not allowed due to increased noise generated and increase power utilized. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point.] Motors shall be UL Recognized and CSA Certified. Single condenser fan running at max RPM and design static pressure shall not exceed an A-weighted sound power level of 75 db at free inlet/outlet test conditions.

M. Packaged DX Control and Diagnostics: The Packaged DX system shall be controlled by an onboard digital controller (DDC) that indicates both Client Agency-supplied settings and fault conditions that may occur. The DDC shall be programmed to indicate the following faults:

1. Global alarm condition (active when there is at least one alarm)
2. Supply Air Proving alarm
3. Dirty Filter Alarm
4. Compressor Trip alarm
5. Compressor Locked Out alarm
6. Supply Air Temperature Low Limit alarm
    a. Sensor #1 Out of Range (outside air temperature)
    b. Sensor #2 Out of Range (supply air temperature)
    c. Sensor #3 Out of Range (cold coil leaving air temperature)

N. Phase and brownout protection: Unit shall have a factory-installed phase monitor to detect electric supply phase loss and voltage brown-out conditions. Upon detection of a fault, the monitor shall disconnect supply voltage to all motors.

O. Motorized dampers / Intake Air, Motorized dampers of low leakage type shall be factory installed.

P. Curb Assembly: A curb assembly made of 14 gauge galvanized steel shall be provided by the factory for assembly and installation as part of this division. The curb assembly

shall provide perimeter support of the entire unit and shall have duct adapter(s) for supply air. Curb assembly shall enclose the underside of the unit and shall be sized to fit into a recess in the bottom of the unit. Contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly. The curb shall be the height of 14 in.

2.4. BLOWER

A. Blower section construction, Supply Air: direct drive motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.

B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

C. Fan: Direct drive, airfoil plenum fan with aluminum wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.

D. Blades: Welded aluminum blades only.

E. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5. MOTORS

A. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.

B. Motors shall be 60 cycle, 3 phase 460 volts.

2.6. UNIT CONTROLS

A. The unit shall be constructed so that it can function as a stand-alone heating and cooling system controlled by factory-supplied controllers, thermostats and sensors or it can be operated as a heating and cooling system controlled by a Building Management System (BMS). This unit shall be controlled by a factory-installed microprocessor programmable controller (DDC) that is connected to various optional sensors.

B. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status. DDC controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-

installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Client Agency-specified ventilating conditions can be input by means of pushbuttons.

C. Unit supply fan shall be configured for Constant Volume (ON/OFF).

D. Unit exhaust fan shall be configured for

E. Outside Air / Return Air damper control shall be field adjustable two-position.

F. Operating protocol: The DDC shall be factory-programmed for BACNetMSTP.

G. Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drive for modulation of the exhaust air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

2.7. FILTERS

A. Unit shall have permanent 2 inch (50.8 mm) aluminum filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 disposable pleated filters shall be provided in the supply final air stream.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.

B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.

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

3.2. INSTALLATION

A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

3.3. CONNECTIONS

A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.

B. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings, and specialties.

C. Duct installation and connection requirements are specified in Division 23 of this document.

D. Electrical installation requirements are specified in Division 26 of this document.

3.4. FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A / E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

3.5. START-UP SERVICE

A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.6. DEMONSTRATION AND TRAINING

A. Engage a factory authorized service representative to train Client Agency’s maintenance personnel to adjust, operate and maintain the entire unit.

END OF SECTION 237433

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 GENERAL

1.1 STIPULATIONS

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

1.2 SYSTEM DESCRIPTION

A. The heat pump air conditioning system shall be a York Duct Free Split (DFS) DX (Direct Expansion), inverter driven single-zone split system as specified. The system shall consist of a horizontal discharge, single phase outdoor unit using R-410A with a matched capacity indoor unit that shall be equipped with a wired wall-mounted or wireless handheld remote controller. Single zone systems will be connected via refrigerant piping and control wiring.

B. The JCI Duct Free Split system efficiency shall be at a minimum 16 SEER, 7.3 EER, and 8.2 HSPF. The system must provide a rated cooling and heating capacity as shown on the mechanical schedule.

1.3 QUALITY ASSURANCE

A. All wiring shall be in accordance with the National Electrical Code (NEC).

B. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

C. The units shall be Intertek ETL Listed (Canada and USA), signifying that they comply with the standard of Heating and Cooling Equipment (ANSI/UL 1995 and CAN/CSA C22.2 No. 236-11, 4th Edition, October 14, 2011).

D. The units shall be certified by the Air Conditioning, Heating & Refrigeration Institute.

E. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for split systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute to AHRI STD. 210/240.

1.4 DELIVERY, STORAGE AND HANDLING

A. The units shall be stored and handled according to the manufacturer's recommendations. DFS units and controls shall be stored and protected from weather elements and harsh conditions as suggested by the manufacturer. All storage, lifting, and moving instructions must be followed as marked on the boxes and as suggested by the manufacturer.

PART 2 – WARRANTY

A. The York Duct Free Split (DFS) equipment and controls shall be covered by the manufacturer limited warranty for a period of seven (7) years from date of unit installation. The unit's parts shall have a manufacturer's limited warranty for a period of five (5) year from date of unit installation. With proper registration within 60 day of install, the warranty will move to a 10 years Compressor/10 years parts. If product is not registered within 60 days, only the standard warranty will apply.

B. The York Duct Free Split (DFS) system shall be installed by a professional mechanical contractor.

PART 3 – PERFORMANCE

A. The York Duct Free Split (DFS) systems shall perform as indicated on the mechanical schedules.

PART 4 - PRODUCTS

4.1 MANUFACTURERS

B. Manufacturers: Subject to compliance with requirements, provide products indicated on drawings or comparable product by one of the following:
   1. Mitsubishi Electric.
   2. Daikan AC.
   3. LG.
   4. Or equal as approved by Professional.

4.2 OUTDOOR UNIT

A. General:
1. The York Duct Free Split (DFS) outdoor unit is designed specifically for use with York DFS indoor units and components.
2. The Outdoor unit capacity must be matched to the indoor unit capacity to ensure the system will operate with appropriate capacity as required by the design for the space/load.
3. All additional DFS accessories and components shall be qualified and approved by the manufacturer of the DFS equipment.
4. The outdoor unit shall be factory assembled, piped, wired, as well as run tested at the factory.
5. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions.
6. The outdoor unit shall be factory assembled with all controls functionality.
7. The unit shall be capable of low ambient cooling down to 0F (W series).
8. The outdoor unit shall have a tested sound pressure rating no more that 61dB (A).
9. The DFS system shall have multiple refrigerant piping and use R-410A refrigerant.

B. Unit Cabinet:
1. The York Duct Free Split (DFS) condensing unit casing shall be fabricated of galvanized steel and coated with a baked enamel finish with removable panels to allow access to major components for servicing the equipment.
2. Outdoor units shall have base legs to secure the unit during installation.
3. Outdoor units shall be wind load certified up to 186 mph up to 50ft in compliance with wind load criteria set forth by 2014 Florida building code Mechanical section 301.15, Florida building code Building chapter 16 and ASCE 7-10
4. The coil fins shall have a factory applied corrosion resistant Bluefin material with hydrophilic coating. Coil coating shall be tested in accordance with ASTM B-117 salt spray test procedure for a minimum of 500 hours.
5. The condensing unit shall have multi-point diagnostics.

C. Operating Temperature Ranges:
1. The operating ranges Multi Zone systems shall be as follows:

Category	Range
M Series standard Cooling Operating Range	23°F to 118°F
W Series standard Cooling Operating Range	0°F to 118°F

M Series Operating Range - Heating (DB)	5°F to 80°F
W Series Operating Range - Heating (DB)	-4 °F to 86°F

D. Piping:
1. The system shall be capable of operation with the published manufacturer maximum refrigerant length data reference in the performance tables.
2. The condensing unit shall have the ability to operate with the published manufacturer maximum height data referenced in the performance tables with respect to the indoor unit.
3. All refrigerant lines from the outdoor unit to the indoor unit shall be field installed and insulated separately.

E. Fan:
1. The condensing unit shall be furnished with a single DC fan motor.
2. All fans shall be provided with a fan guard grill to prevent injury. Fan guards shall be fabricated of steel wire rods.
3. The condensing unit shall have a horizontal discharge airflow. The fan shall be located in front of the condensing coil, pulling air from the rear and discharging the air through the front.

F. Coil Information:
1. Condensate Pan with Drain connection under the coil.
2. The coil of the outdoor unit shall be of stamped aluminum louvered fins to improve heat transfer capability on copper tubing.
3. The coil fins shall be coated with corrosion resistant material. Coil coating shall be salt spray tested of 500 hours.
4. The outdoor coil shall be protected with a pre-coated metal guard.

G. Sound:
5. The condensing unit shall have sounds levels as low as 61 for Multi Zone, 59 for Single Zone.

H. Compressor:
1. All York Duct Free Split (DFS) outdoor units shall be equipped with a single digitally controlled, inverter driven rotary compressor.
2. The compressor shall have the ability to vary its speed to meet the exact room load in order to increase efficiency which results in energy cost savings.
3. Compressors shall be mounted inside the condensing unit at the factory to standards in order to avoid transmission of vibration.
4. Compressors shall have small torque fluctuation, low vibration, and a wide rotation speed range.

5. Compressor capacity shall be modulated automatically while varying the refrigerant flow for the needs of the cooling or heating loads.

I. Refrigerant:
1. The condensing unit will be factory charged with R-410A.
2. Depending on the size and length of the piping when installed, it may require additional trim charging in the field.

J. Electrical:
1. The condensing unit power supply shall be 208/230V, 1 phase, 60 Hertz.

4.3 INDOOR UNIT – 4-WAY CASSETTE

A. General:
1. The unit shall have the ability to be recessed into the ceiling with a ceiling grill and shall be a 4-way air distribution type.
2. The unit shall be factory assembled, piped, wired, as well as run tested at the factory.
3. The unit and refrigerant pipes will be charged with dehydrated air (nitrogen gas) prior to shipment from the factory.
4. The 4-way cassette shall be equipped with an electronic expansion valve.
5. The 4-Way Cassettes shall be equipped with a built-in condensate pump with 11” lift.
6. The unit shall have an automatic swing louver.
7. The unit shall be capable of infrared remote control as well as remote control lock out.
8. The unit shall come equipped with wireless remote controller.

B. Performance:
1. Each 4-way cassette’s performance is based on nominal operating conditions shown in mechanical schedules.

C. Unit Cabinet:
1. The unit cabinet shall be space savings and have the ability to be recessed into a ceiling.
2. The 4-way panel shall be affixed to the bottom of the unit allowing for 4-way airflow.
3. The 4-way cassette (without panel) shall be no larger than 33” x 9.5” x 33” (W x H x D) and weigh no more than 11 lbs.

D. Fan:
   1. Unit shall be equipped with a brushless DC fan motor drive.
   2. The 4-way cassette shall consist of 3 fan speeds.

E. Coil Information:
   1. The coil of the outdoor unit shall be of stamped aluminum louvered fins to improve heat transfer capability on copper tubing.
   2. The coil fins shall be coated with corrosion resistant material.
   3. All refrigerant lines to the indoor unit shall be field installed and shall be insulated separately.
   4. A non-metallic condensate drain pan with drain connections shall be factory installed below the coil.

F. Filter:
   1. The standard air filter shall be of an anti-mold polypropylene that is also a washable type.

G. Sound:
   1. The 4-way cassette sound pressure shall range 37 dB(A) to 46 dB(A)

H. Electrical:
   1. The unit shall be 208-230V, I phase, 60 Hertz.
   2. Indoor unit is powered from the outdoor unit

I. Control:
   1. Controller provide on/off set point adjustment, fan speed adjustment.
   2. Fault diagnostic.
   3. Controller provide on/off set point adjustment, fan speed adjustment.
   4. Indoor Circuit Board: able to process and receive indoor unit sensor values such as coil sensor temperatures, air return, and set point settings commands from the remote controller.
   5. Unit shall be BACnet compatible.

PART 5 - EXECUTION

5.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:
   1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

5.2 CONNECTIONS

A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

5.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

5.4 DEMONSTRATION

A. Train Client Agency’s maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 210000

GENERAL REQUIREMENTS FOR FIRE PROTECTION TRADES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.1 GENERAL

A. Applicable portions of all documents listed in the index apply to work of this section.

B. Provisions stated in this section are applicable to all sections of the Division 21 Fire Protection Specifications and to all phases of the Fire Protection work shown on the drawings.

C. The "Materials and Equipment" paragraph of this section shall take precedence over all related provisions of Division 1 Section, which may conflict with this section.

1.2 SINGULAR NUMBER

A. In all cases where a device or piece of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation. Quantity determinations of all materials and equipment shall be the complete responsibility of the Contractor.

1.3 DEFINITIONS

A. The following are definitions of terms and expressions used throughout Division 23 specifications:
   1. Client Agency - Department of Human Services
   2. Professional - Martin Rogers Associates, P.C.
   3. Provide - Furnish and install.
   4. Work - Plant, labor, and material.
   5. Directed - Directed by the Professional.
   6. Indicated - Indicated by the contract documents

7. Concealed - Hidden from sight; includes items in shafts, pipe and duct spaces, and above ceilings.
8. Exposed - Not concealed; work within equipment rooms and exposed to view by the occupant shall be considered exposed.
9. Piping - Includes pipes, fittings, valves, hangers, and accessories comprising a system.

1.4 SCOPE OF WORK

A. This Section includes general administrative procedures and requirements for mechanical installations, as well as basic materials and methods of construction for the installation of mechanical systems.

B. The following administrative procedures and requirements are included in this section to expand and supplement the requirements specified in the front end of this specification:
1. Work included
2. Work excluded
3. Intent of drawings
4. Contract drawings
5. Coordination drawings
6. Record drawings
7. Codes, permits, approvals
8. Inspections
9. Materials and equipment
10. Submittals/shop drawings
11. Contractor’s responsibilities - submittals
12. Substitution of materials and equipment
13. Performance of equipment
14. Guaranty/warranty
15. Operating and maintenance manuals
16. Charts
17. Temporary Heat

C. The following basic materials and methods of construction for the installation of plumbing systems are included in this section:
1. Vibration Control
2. Accessibility
3. Examination of site

4. Dimension of existing structures
5. Lines, grades, and measurements
6. Coordination
7. Delivery, storage, and handling
8. Protection
9. Cutting and patching
10. Equipment installation and connections
11. Mounting mechanical devices in suspended ceilings

1.5 WORK INCLUDED

A. Work under Division 22 of the specifications of the contract shall include all plant, labor, and material required to complete the work as shown on the drawings, hereinafter specified, or both. Work of this contract shall include but not be limited to the items outlined in each of the Division 22 sections herein. Work generally includes:
   1. Plumbing:
      - Miscellaneous demolition as noted and as shown where required.
      - Miscellaneous general construction as noted.
      - New, quick-response, fully-concealed sprinklers.
      - New, quick response, ligature resistant, institutional sprinklers.
      - Fire protection piping and specialties.
      - Hangers and supports, as specified and as shown where required.
      - Coordination of ceiling heights and clearances with General, HVAC, Plumbing and Electrical Contractors necessary to accomplish effective Fire Protection in harmony with the architectural design.
      - Testing, adjusting, and balancing of all work installed.
      - Client Agency training on operation and maintenance of all systems and equipment.

1.6 WORK EXCLUDED

A. All work shown or specified shall be included in the Contract unless specifically mentioned herein.

1.7 INTENT OF DRAWINGS

A. The Contractor generally responsible for the trade of a specific drawing shall provide all work indicated on that drawing unless explicitly indicated otherwise. For example:
   1. H-# drawings - HVAC Contractor
   2. P-# drawings - Plumbing Contractor
   3. FP-# drawings - Fire Protection Contractor

B. Work may include items that may relate to other major trades. Specifically, all work indicated on the "FP" drawings (Plumbing) shall be provided by the Fire Protection Contractor unless specifically indicated to be provided by others. The same principle shall apply to "H" drawings (HVAC), "P" drawings (Plumbing), etc.

1.8 CONTRACT DRAWINGS

A. Drawings that constitute a part of this contract indicate the general arrangement of piping, ductwork, accessories, equipment, and other work. It is the intent of these drawings and specifications to describe a complete and integrated system. It is understood that while the drawings may not show every pipe, valve, and detail, all equipment and accessories that are reasonably inferable from the drawings and specifications as being necessary for the completion and proper performance of the work shall be included even though not specifically mentioned. What is called for on either the drawings or in the specifications shall be as binding as if called for on both.

B. It is understood that while the drawings shall be followed as closely as circumstances will permit, the Contractor is held responsible for the proper installation of materials and equipment to the true intent and meaning of plans and specifications. If any equipment, piping, or ductwork cannot be installed as shown, the Contractor shall consult with the Professional before making any changes.

1.9 COORDINATION DRAWINGS

A. The contractor shall prepare coordination drawings for the building. Drawings shall be coordinated among all trades and shall be generated in Revit.

B. Coordination drawings shall be prepared to a scale of 1/4”=1’-0” or larger, detailing major elements, components, and systems of mechanical equipment and materials in relationship to other systems, installations and building components.

C. Coordination drawings shall include plans of each area and sections of congested area.

D. Coordination drawings shall:
   1. Indicate the proposed locations of any piping, ductwork, equipment and materials relating to the following:
      a. Exterior wall and foundation penetrations
      b. Equipment pads and bases

c. Clearances for installing, servicing and maintaining equipment, including tube removal, filter removal and space for equipment disassembly required for periodic maintenance.
d. Equipment service connections and support details.
e. Ceiling plenums, chases, shafts, trenches, and other tight and congested spaces
f. Piping system layout, include elbows, radii, and accessories.

2. Indicate the proposed scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Include floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. Include reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.10 RECORD DRAWINGS

A. During construction, the Contractor shall maintain a record set of contract drawings, and shall record on this set in colored pencil all deviations from the original in pipe, duct, or equipment sizes, locations, and other pertinent details.

B. Upon completion of the work, Contractor shall forward these marked prints to the Professional for review.

1.11 CODES, PERMITS, APPROVALS

A. All required local, state and utility company permits and approvals shall not be obtained by the Contractor. The design Professional shall submit to the Pennsylvania Department of Labor and Industry for all Construction permits. Fees do not apply.

B. All persons digging at the site shall notify PA ONE CALL at 1-800-272-1000.

C. All Fire Protection work shall comply with all applicable provisions of the International Building Codes (IBC), latest edition adopted by the Commonwealth of Pennsylvania, including the International Fire Code (IMC) and NFPA (National Fire Protection Association).

E. All work shall meet the requirements and standards of the several Utility Company(s) serving the project. Install and test backflow preventers in accordance with regulations of the serving utility company.

F. All materials furnished shall meet the ASTM Specifications latest revisions.

G. All electrical work shall be in conformance with the latest edition of the National Electrical Code (NEC).

H. In all cases, the local Authority-Having-Jurisdiction (AHJ) has the right to impose a higher standard of care than the basic codes listed herein. The contractor shall be familiar with the requirements of and, if unsure, consult with the local AHJ, and make due allowance for more stringent stipulations if necessary. The contractor shall be responsible for all additional work and related costs to comply with the requirements of the local AHJ where such requirements differ from those listed in the basic building code(s).

1.12 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be new, the best of their respective kinds, and suitable for the conditions and duties imposed on them at the building. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

B. All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, and any other imperative information in order to facilitate their maintenance or replacement. The nameplate of a subcontractor or distributor will not be acceptable.

C. All equipment requiring electrical service shall be UL labeled. If a UL label is not available from the manufacturer, when requested or required by the local authority having jurisdiction, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Client Agency. Submit data indicating compliance with standards prior to installation.

D. The contractor understands that:
   1. The Professional will use their own judgment in determining whether or not any materials, equipment or methods offered for review as an equivalent are equivalent to those specified.
   2. The decision of the Professional on all such questions of equivalency is final.
   3. Any acceptable material, equipment, and methods will be provided at no increase in cost to the Client Agency.

1.13 SUBMITTALS AND SHOP DRAWINGS

A. After receiving approval of the source of supply list; furnish catalog data, dimensional data, performance specifications, etc., in sufficient detail to properly identify and judge each item. Each item or equipment proposed shall be a standard product of the approved manufacturer.

B. Samples, drawings, specifications, catalogs, etc., submitted for review shall be dated, properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name, and name of job.

C. Review of shop drawings or samples by the Professional shall not relieve the Contractor of responsibility for any deviation from the requirements of the contract documents. Deviations from the contract documents will only be allowed if all the following are satisfied:
- The Contractor has informed the Professional in writing of all deviations at the time of submission,
- The Contractor has noted the deviation on the shop drawings,
- The Professional has acknowledged, in writing, the specific deviation.

D. In any event, the Professional's review shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.

E. No materials or equipment shall be purchased, delivered to the site, or installed until they have been reviewed by the Professional. Review of any submittal shall not relieve the Contractor of responsibility for deviation from the drawings or specifications, nor shall it relieve the Contractor from errors in the submittals. Dimensions and quantities shall, in all cases, be the complete responsibility of the Contractor.

F. Subsequent to the Professional's review of a submittal, it shall be marked with one or more comments as defined below:
- No Exceptions Taken: The contractor may proceed using the reviewed material,
- Note Markings: The contractor may proceed using the reviewed material provided corrective action is taken on all comments noted on the submittal,
- Comments Attached: Same as "Note Markings", except that comments have been noted on a supplemental attachment,
- Contractor Confirm: The contractor shall respond in writing to all comments including confirmation that corrective action will be taken on all comments noted prior to proceeding with the work,

- Resubmit: The contractor shall respond to all comments noted, revise shop drawings accordingly, and resubmit for review,
- Rejected: The proposed material or equipment does not comply with the requirements of the contract documents and may not be used for this project.

G. Upon receipt of written notice from the Professional that the material, equipment, or methods have been reviewed and marked "no exceptions taken", "Note Markings", or "Comments Attached", the Contractor may proceed with the reviewed material, equipment, or methods. The Contractor assumes full responsibility for and shall make, at no expense to the Client Agency, all changes or adjustments in construction that may result by the use of such approved materials, equipment or methods, including electrical and other services provided under other divisions of this specification. In the event of any adverse decisions by the Professional, no claim of any sort shall be made or allowed against the Professional or the Client Agency.

H. If material or equipment is installed prior to receipt by the contractor of submittals marked "no exceptions taken", "note markings", or "comments attached", the Contractor shall be liable for its removal and replacement at no extra cost to the Client Agency.

I. Sufficient sets shall be submitted to allow two (2) copies to be retained by the Professional.

J. Materials and equipment requiring submittals are listed in each section of these specifications.

1.14 CONTRACTORS RESPONSIBILITY - SUBMITTALS

A. The Contractor shall submit a letter with each submittal forwarded to the Professional's office for review certifying that they have personally reviewed the material submitted and found it to be satisfactory for this project. This certification shall cover dimensional checking as well as cross checking with the Architectural, HVAC, and/or Electrical documents to insure that no changes will be required in other contracts.

B. Any material submitted to the Professional's office without this Contractor's certification will be returned without action.

C. Whenever alternate equipment is submitted, it shall be accompanied by a 1/4" - 1'0" scale drawing of the mechanical equipment room showing the alternate equipment, all clearances, etc. Submittals without this information will be returned without review or comment.

1.15 SUBSTITUTION OF EQUIPMENT

A. Substitution of equipment of makes other than those specified, after receipt of the bid, will be approved by the Professional only if:
- The equipment proposed for substitution is equivalent or superior to equipment named in terms of construction, efficiency, and utility, and
- That the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence to work of other Contractors, due to conditions beyond control of the Contractor.

B. To receive consideration, requests for substitutions must be accompanied by documentary proof of equivalence or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

C. In case of a difference in price, the Client Agency shall receive all benefit of the difference in cost involved in any substitution, and the contract altered by change order to credit Client Agency with any savings so obtained.

1.16 PERFORMANCE OF EQUIPMENT

A. All materials, equipment, and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples of such material, equipment, and/or appurtenances shall relieve the Fire Protection Contractor of his responsibility to turn over the same to the Client Agency in perfect working order at the completion of the work.

B. If the operation, capacity, or performance of any material, equipment, or appurtenance, does not comply with the drawings and/or specification requirements, or is damaged prior to acceptance by the Client Agency, respective item(s) will be considered defective. All defective items shall be removed and replaced with proper and acceptable materials, equipment, and/or appurtenances, or, put in proper and acceptable working order, satisfactory to the Professional, prior to final payment without additional cost to the Client Agency.

1.17 GUARANTY/WARRANTY

A. Materials, equipment, and systems furnished under these specifications shall be guaranteed against defects in material, design, and workmanship.

B. Contractor shall provide a list of equipment and the warranty periods as a submittal that will be reviewed by the Client Agency and the design team.

C. The guarantee period shall extend until the later of:
- A period of one (1) year from the date of final acceptance,
- Eighteen (18) months from the date of initial start-up.

D. The Contractor shall replace any material or equipment that comprises a part of any system that develops any defect during the guarantee period, at their expense.

E. Contractor shall turn over to the Client Agency all warranties and guarantees upon completion and final acceptance of project.

1.18 OPERATING AND MAINTENANCE MANUALS

A. Contractor shall submit operating and maintenance instructions for all equipment furnished by them.

B. Maintenance and operating instructions shall be manuals prepared by the various manufacturers for the specific equipment furnished. Manuals shall cover such items as start-up procedures, trouble-shooting, periodic maintenance, etc. Advertising literature or catalogs will not be acceptable in this connection.

C. Three (3) sets of the above material shall be submitted to the Professional for review and approval.

C. Final job acceptance date shall be the date stamped on the operating and maintenance instructions and the guarantee period shall generally extend from that date.

1.19 CHARTS

A. Provide permanent type charts, framed under glass, mounted where directed as follows:
1. Valve charts giving valve use, system, and number on tag attached to valve.
2. Equipment and motor list giving system, equipment designation, and motor horsepower.
3. Automatic temperature control schematics and sequences of operation.
4. Lubrication instructions for all equipment giving type of lubricant and frequency.
5. Service organizations with normal and emergency telephone numbers.

6. Abbreviated operating instructions for all mechanical systems.

PART 2 - PRODUCTS

2.1 VIBRATION CONTROL

A. Vibration isolation devices shall be provided in accordance with Chapter 47, Table 42 ("Selection Guide for Vibration Isolation") of the American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc.'s (ASHRAE) 2003 Application Handbook.

2.2 ACCESSIBILITY

A. Locate all equipment that must be serviced, operated, or maintained, in fully accessible locations. Equipment shall include, but not be limited to water heaters, coils, valves, motors, controllers, drain points, traps, strainers, etc. The contractor shall rework, at their expense, any equipment that is deemed inaccessible to the satisfaction of the Professional.

B. Where required or directed by the Professional, provide access panels for access to all equipment where no other means of access is available. All access panels shall be of sufficient size to service and remove the equipment for which they are provided, and in no case shall they have a clear opening less than 8" x 8". Access panels shall be set flush with finished surface and shall be held securely in place by means of integral anchoring lugs.

D. In finished walls they shall be smooth, polished nickel bronze access covers and not less than 8" x 8" openings.

E. Those in floors shall be square nickel bronze non-slip scoriated access covers.

F. Access panels in fire rated walls, floors, shafts, and partitions shall be labeled as such and shall match the rating of the adjacent construction.

G. Access panels larger than 12" x 12" shall be of steel construction, having frames designed to suit the various locations and materials to which they are attached. The frames shall be rabbeted to receive cover and set flush with finished wall or ceiling surface. Covers shall be of rustproof furniture steel of not less than #14 gauge, and shall be secured with suitable clips and locking cams or countersunk screws. Covers shall be flush with the frames and finished wall or ceiling surface.

H. Where accessible or removable ceilings are provided, ceiling panels or tiles may be removed to serve as access panels.

I. In general, access panels will not be indicated on the drawings. It shall be the Contractor's responsibility to anticipate these needs and to provide access panels as previously specified.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE

A. Contractor shall familiarize themselves with all drawings and documents for the entire project.

B. By virtue of submitting a proposal, Contractor accepts the fact that tight conditions will likely occur at various locations. No extras will be approved for necessary variations and/or adjustments that may be required to resolve interferences.

C. Details of proposed changes found necessary by field conditions or other causes shall be submitted to the Professional for approval before proceeding with any such change.

E. No extra compensation will be allowed on account of a difference between actual dimensions and measurements at the site and those indicated on the drawings.

3.2 DIMENSIONS OF EXISTING STRUCTURES

A. Where the dimensions and locations of existing structures are of critical importance in the installation or connection of new work, verify such dimensions and locations in the field before the fabrication of any material or equipment that is dependent on the correctness of such information.

B. This stipulation applies specifically to existing sewer lines, manholes, etc. Establish exact invert of existing lines before beginning installation of any new work.

3.3 LINES, GRADES, AND MEASUREMENTS

A. Make all measurements and check all dimensions necessary for the proper construction of the work called for by the drawings and specifications. During the prosecution of the work, make all necessary measurements to prevent misfitting in said work, and for the accurate construction of the entire work.

3.4 COORDINATION

A. Fire Protection Contractor shall plan all sequences of their portion of the project so that the work proceeds with a minimum of interference with other trades. They shall cooperate with all other Contractors in coordinating the locations of piping, ducts, etc., with lighting fixtures, structural members, sprinkler heads, etc.

B. Fire Protection Contractor shall check all project drawings prior to installing any equipment, pipes, ducts, etc. Any conflicts that become apparent as a result of cross checking drawings shall be resolved with the Professional prior to any work being done. Minor adjustments in location, size, and type of materials necessary to work out any interference shall be made at no extra cost. Being installed "first" in any particular situation will not be considered a factor in the proper resolution of a conflict.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification; adequately packaged and protected to prevent damage during shipment, storage, and handing.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. If any materials or equipment are found to be damaged or in poor condition at the time installation, the Professional may, at their discretion, order the Contractor to furnish and install new materials or equipment at no additional expense to the Client Agency.

3.6 PROTECTION

A. Protect all work, equipment, and materials at all times. All pipe openings shall be capped and plugged during installation.

B. All necessary precautions shall be taken to prevent damage to any work, materials, or equipment furnished by the Contractor. The Contractor shall be held responsible for all

damage incurred to his work, materials, and equipment until his portion of the project is fully and finally accepted.

C. Plumbing Contractor shall adequately cover and protect all plumbing fixtures as may be necessary until completion of the work. Plumbing Contractor shall be responsible for damage or breakage to fixtures and shall make good such damaged items at no cost to the Client Agency.

D. Drainage lines shall be kept free of dirt, concrete, or debris during the course of construction. The contractor shall correct any blockages resulting from the above.

E. Carefully make-up piping or accessories having polished, plated, or finished surfaces to avoid scarring. Protect fixtures or equipment having finished surfaces before, during, and after installation with special protective coatings for this purpose.

F. Do not install exposed polished metal fittings, parts, and devices, until adjoining tile or masonry has been finally acid cleaned.

G. All equipment, devices, controls, and motors shall be tightly covered and protected during construction up to the time of operation. Protection shall be arranged and of such design to prevent damage by infiltration of dust, dirt, debris, moisture, chemicals, or water. Minimum protection shall be by covering with transparent plastic sheeting to the satisfaction of the Professional.

H. The Fire Protection Contractor shall likewise protect from damage all materials, new and existing, turned over to them by others (including the Client Agency) for installation. The Contractor shall replace any material that becomes damaged at their expense.

3.8 CUTTING AND PATCHING

A. Fire Protection Contractor shall do all cutting necessary to properly install their materials, except as noted hereafter. This shall include cutting of existing concrete floors and walls. Cutting and patching of every nature required in connection with this Contract shall be done with mechanics experienced in their respective lines of work. All patching shall match adjacent finishes.

B. All cutting in the building shall be done with great care so as not to leave an unsightly surface that may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through fault of the Contractor, they shall be required to correct such deficiencies to the satisfaction of the Professional.

C. All holes for piping shall be core drilled through existing concrete floors and walls.

D. No cutting of structural members shall be done until approval has been received from the Professional.

E. Fire Protection Contractor(s) shall do all patching required to restore the substrate to a condition that will readily receive new finishes. The General Contractor shall provide all new finishes; tile, plaster, paint, etc.

F. Fire Protection Contractor shall provide the General Contractor or any other Contractors, which may be affected by his work, locations, and sizes of chases, sleeves, and openings required for installation of pipes, ducts, and other equipment. This information shall be presented to the General Contractor previous to pouring concrete or erecting walls to avoid unnecessary cutting and patching.

G. If openings are omitted or are incorrect through failure of the contractors to follow these instructions, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Professional.

3.9 EQUIPMENT INSTALLATION AND CONNECTIONS

A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

B. Any conflicts between the installation instructions indicated on the contract documents and the manufacturer's instructions and recommendations shall be brought to the attention of the Professional for resolution. The Professional's decision as to the final equipment installation and connections is final and any modifications necessary to obtain such an installation shall be made at no expense to the Client Agency.

3.10 MOUNTING FIRE PROTECTION DEVICES IN SUSPENDED CEILINGS

A. Support fire protection piping, sprinklers, etc. independently from ceilings.

B. Contractor shall carefully check existing suspension system for adequacy and completeness. He shall also test its supporting strength where additional weights are to be added due to changes of the existing HVAC or Electric systems.

END OF SECTION 230000

SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   4. Escutcheons.
   5. Grout.
   6. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, 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 chases.

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.

1.4 SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

C. 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.

D. Electrical Characteristics for Fire-Suppression 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.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 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.

2.2 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless A-Cead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

E. Welding Filler Metals: Comply with AWS D10.12.

2.3 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.4 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated and rough brass.

2.5 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, 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.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying 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. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. 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.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. 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.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

P. Verify final equipment locations for roughing-in.

Q. 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 Division 21 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. 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.

3.3 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 fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION 210500

SECTION 210529

HANGERS AND SUPPORTS FOR FIRE SUPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Fastener systems.
   5. Equipment supports.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Include design calculations for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:
   1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Flex-Strut Inc.
      c. Unistrut; Part of Atkore International.
      d. Equal as approved by Professional.

   2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
   3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
   4. Channels: Continuous slotted carbon-steel channel with inturned lips.
   5. Channel Width: Selected for applicable load criteria.

6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: No coating.
9. Paint Coating: Green epoxy, acrylic, or urethane.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International.
   b. Carpenter & Paterson, Inc.
   c. ERICO International Corporation.
   d. Equal as approved by Professional.

2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: No coating.
9. Paint Coating: Green epoxy, acrylic, or urethane.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   c. MKT Fastening, LLC.
   d. Equal as approved by Professional.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. B-line, an Eaton business.
   b. Hilti, Inc.
   c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
   d. Equal as approved by Professional.

2. Indoor Applications: Zinc-coated or Stainless steel.
3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.

D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.

2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal 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 that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

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 bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099123 "Interior Painting."

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
   3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
   6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

9. 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.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Comply with NFPA requirements.

L. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

M. Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 210529

SECTION 211313

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

1.3 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated. System and all equipment shall be approved by the local AHJ.

1.4 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
1. Available fire pump flow test records indicate the following conditions:
a. Date: 04-18-2023.
b. Performed by: Jensen Hughes, Inc.

c. Location of Fire Pump: Campus fire pump building.
d. Suction Pressure of Fire Pump at 100%: 28 psi.
e. Discharge Pressure of Fire Pump at 100%: 86 psi.
f. Net Pressure of Fire Pump at 100%: 750 gpm.

C. Sprinkler system design shall be approved by authorities having jurisdiction.
1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
a. Building Service Areas: Ordinary Hazard, Group 1.
b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
c. General Storage Areas: Ordinary Hazard, Group 1.
d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
e. Office and Public Areas: Light Hazard-Quick Response.
3. Minimum Density for Automatic-Sprinkler Piping Design:
a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
4. Maximum Protection Area per Sprinkler: Per UL listing.
5. Maximum Protection Area per Sprinkler:
a. Office Spaces: 120 sq. ft., 225 sq. ft..
b. Storage Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft..
d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

1.5 SUBMITTALS

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

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Qualification Data: For qualified Installer.

E. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by FM Global and the authorities having jurisdiction, including hydraulic calculations if applicable.

F. Welding certificates.

G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

H. Field quality-control reports.

I. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:
1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
1. NFPA 13, "Installation of Sprinkler Systems."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 30, Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 30 and not more than Schedule 40. Pipe ends may be factory or field formed to match joining method.

C. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.

D. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

E. Uncoated, Steel Couplings: ASTM A 865, threaded.

F. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

G. Malleable- or Ductile-Iron Unions: UL 860.

H. Cast-Iron Flanges: ASME 16.1, Class 125.

I. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

J. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

K. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Anvil International, Inc.
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Equal as approved by the Professional.
   2. Pressure Rating: 175 psig minimum.
   3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

L. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Victaulic Company.
b. Equal as approved by the Professional.

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
1. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
1. Valves shall be UL listed or FM approved.
2. Minimum Pressure Rating: 175 psig.

B. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve; a division of McWane, Inc.
b. Victaulic Company.
c. Viking Corporation.
d. Equal as approved by the Professional.

2. Standard: UL 312.
3. Pressure Rating: 250 psig.
4. Type: Swing check.
5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

C. Bronze OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Equal as approved by the Professional.
2. Standard: UL 262.
3. Pressure Rating: 175 psig.
4. Body Material: Bronze.
5. End Connections: Threaded.

D. Iron OS&Y Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Equal as approved by the Professional.
2. Standard: UL 262.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Cast or ductile iron.
5. End Connections: Flanged or grooved.

E. Indicating-Type Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kennedy Valve; a division of McWane, Inc.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
   d. Equal as approved by the Professional.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig minimum.
4. Valves NPS 2 and Smaller:
   a. Valve Type: Ball or butterfly.
   b. Body Material: Bronze.
   c. End Connections: Threaded.
5. Valves NPS 2-1/2 and Larger:
   a. Valve Type: Butterfly.

b. Body Material: Cast or ductile iron.
c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, two-circuit, supervisory switch indicating device.

2.5 TRIM AND DRAIN VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.

B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Kennedy Valve; a division of McWane, Inc.
b. Milwaukee Valve Company.
c. NIBCO INC.
d. Equal as approved by the Professional.

2.6 SPECIALTY VALVES

A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc.
b. Victaulic Company.
c. Viking Corporation.
d. Equal as approved by the Professional.

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber**,** and fill-line attachment with strainer.

5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

C. Automatic (Ball Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. AFAC Inc.
b. Reliable Automatic Sprinkler Co., Inc.
c. Tyco Fire & Building Products LP.
d. Equal as approved by the Professional.
2. Standard: UL 1726.
3. Pressure Rating: 175 psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.7 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.
d. Equal as approved by the Professional.
2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Victaulic Company.

d. Equal as approved by the Professional.

2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Elkhart Brass Mfg. Company, Inc.
b. Fire-End & Croker Corporation.
c. Potter Roemer.
d. Equal as approved by the Professional.
2. Standard: UL 199.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Tyco Fire & Building Products LP.
b. Victaulic Company.
c. Viking Corporation.
d. Equal as approved by the Professional.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. CECA, LLC.
b. Corcoran Piping System Co.
c. Merit Manufacturing; a division of Anvil International, Inc.
d. Equal as approved by the Professional.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Victaulic Company.
b. Viking Corporation.
c. Reliable Automatic Sprinkler Co , Inc.
d. Equal as approved by the Professional.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.8 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Viking Corporation.
4. Equal as approved by the Professional.

B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:
1. Chrome plated.
2. Bronze.
3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Reliable Automatic Sprinkler Co., Inc.
b. Tyco Fire & Building Products LP.
c. Viking Corporation.
d. Equal as approved by the Professional.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ADT Security Services, Inc.
b. Potter Electric Signal Company.
c. Viking Corporation.
d. Equal as approved by the Professional.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.

4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Kennedy Valve; a division of McWane, Inc.
   b. Potter Electric Signal Company.
   c. System Sensor; a Honeywell company.
   d. Equal as approved by the Professional.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.10 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
2. Ashcroft, Inc.
3. Brecco Corporation.
4. Equal as approved by the Professional.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."

B. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install alarm devices in piping systems.

J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

K. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

L. Fill sprinkler system piping with water.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Common Work Results for Fire-Suppression"

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section " Common Work Results for Fire-Suppression."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section " Common Work Results for Fire-Suppression."

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Start and run excess-pressure pumps.
6. Coordinate with fire-alarm tests. Operate as required.
7. Coordinate with fire-pump tests. Operate as required.
8. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.9 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.

C. Wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Standard-weight or Schedule 30, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
6. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Thinwall black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
8. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.
9. Schedule 5 steel pipe; steel pressure-seal fittings; and pressure-sealed joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be one of the following:
   1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
   2. Standard-weight or Schedule 30, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
   3. Standard-weight or Schedule 30, black-steel pipe with cut-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   4. Standard-weight or Schedule 30, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   5. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.
   6. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
   7. Thinwall black-steel pipe with plain ends; welding fittings; and welded joints.

3.10 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Pendent, recessed, flush, institutional and concealed sprinklers as indicated.
   3. Wall Mounting: Sidewall sprinklers.
   4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
   1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
   2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
   3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
   4. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 220000

GENERAL REQUIREMENTS FOR PLUMBING TRADES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.1 GENERAL

A. Applicable portions of all documents listed in the index apply to work of this section.

B. Provisions stated in this section are applicable to all sections of the Division 22 Plumbing Specifications and to all phases of the Plumbing work shown on the drawings.

C. The "Materials and Equipment" paragraph of this section shall take precedence over all related provisions of Division 1 Section, which may conflict with this section.

1.2 SINGULAR NUMBER

A. In all cases where a device or piece of equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation. Quantity determinations of all materials and equipment shall be the complete responsibility of the Contractor.

1.3 DEFINITIONS

A. The following are definitions of terms and expressions used throughout Division 23 specifications:
1. Client Agency - Department of Human Services
2. Professional - Martin Rogers Associates, P.C.
3. Provide - Furnish and install.
4. Work - Plant, labor, and material.
5. Directed - Directed by the Professional.
6. Indicated - Indicated by the contract documents

7. Concealed - Hidden from sight; includes items in shafts, pipe and duct spaces, and above ceilings.
8. Exposed - Not concealed; work within equipment rooms and exposed to view by the occupant shall be considered exposed.
9. Piping - Includes pipes, fittings, valves, hangers, and accessories comprising a system.
10. ATC - Automatic Temperature Control.
11. DDC - Direct Digital Control.

1.4 SCOPE OF WORK

A. This Section includes general administrative procedures and requirements for mechanical installations, as well as basic materials and methods of construction for the installation of mechanical systems.

B. The following administrative procedures and requirements are included in this section to expand and supplement the requirements specified in the front end of this specification:
1. Work included
2. Work excluded
3. Intent of drawings
4. Contract drawings
5. Coordination drawings
6. Record drawings
7. Codes, permits, approvals
8. Inspections
9. Materials and equipment
10. Submittals/shop drawings
11. Contractor’s responsibilities - submittals
12. Substitution of materials and equipment
13. Performance of equipment
14. Guaranty/warranty
15. Operating and maintenance manuals
16. Charts
17. Temporary Heat

C. The following basic materials and methods of construction for the installation of plumbing systems are included in this section:
1. Vibration Control

2. Accessibility
3. Examination of site
4. Dimension of existing structures
5. Lines, grades, and measurements
6. Coordination
7. Delivery, storage, and handling
8. Protection
9. Cutting and patching
10. Equipment installation and connections
11. Mounting mechanical devices in suspended ceilings

1.5 WORK INCLUDED

A. Work under Division 22 of the specifications of the contract shall include all plant, labor, and material required to complete the work as shown on the drawings, hereinafter specified, or both. Work of this contract shall include but not be limited to the items outlined in each of the Division 22 sections herein. Work generally includes:

1. Plumbing:
   - Miscellaneous demolition as noted and as shown where required.
   - Miscellaneous general construction as noted.
   - Semi-instantaneous, steam-fired domestic water heaters, pumps, expansion tanks, air separators, and accessories.
   - Domestic water cold, hot and hot water return piping and specialties as indicated and specified.
   - Air conditioning condensate piping and specialties.
   - Hangers and supports, as specified and as shown where required.
   - Thermal insulation as specified and as shown where required.
   - Interconnection into existing Building Management System (BMS).
   - Coordination of ceiling heights and clearances with General, HVAC and Electrical Contractors necessary to accomplish effective Plumbing in harmony with the architectural design.
   - Factory start-up for all major Plumbing equipment.
   - Testing, adjusting, and balancing of all work installed.
   - Client Agency training on operation and maintenance of all systems and equipment.

1.6 WORK EXCLUDED

A. All work shown or specified shall be included in the Contract unless specifically mentioned herein.

1.7 INTENT OF DRAWINGS

A. The Contractor generally responsible for the trade of a specific drawing shall provide all work indicated on that drawing unless explicitly indicated otherwise. For example:
   1. H-# drawings - HVAC Contractor
   2. P-# drawings - Plumbing Contractor
   3. FP-# drawings - Fire Protection Contractor

B. Work may include items that may relate to other major trades. Specifically, all work indicated on the "P" drawings (Plumbing) shall be provided by the Plumbing Contractor unless specifically indicated to be provided by others. The same principle shall apply to "H" drawings (HVAC), "FP" drawings (Fire Protection), etc.

1.8 CONTRACT DRAWINGS

A. Drawings that constitute a part of this contract indicate the general arrangement of piping, ductwork, accessories, equipment, and other work. It is the intent of these drawings and specifications to describe a complete and integrated system. It is understood that while the drawings may not show every pipe, valve, and detail, all equipment and accessories that are reasonably inferable from the drawings and specifications as being necessary for the completion and proper performance of the work shall be included even though not specifically mentioned. What is called for on either the drawings or in the specifications shall be as binding as if called for on both.

B. It is understood that while the drawings shall be followed as closely as circumstances will permit, the Contractor is held responsible for the proper installation of materials and equipment to the true intent and meaning of plans and specifications. If any equipment, piping, or ductwork cannot be installed as shown, the Contractor shall consult with the Professional before making any changes.

1.9 COORDINATION DRAWINGS

A. The contractor shall prepare coordination drawings for the building. Drawings shall be coordinated among all trades and shall be generated in Revit.

B. Coordination drawings shall be prepared to a scale of 1/4”=1’-0” or larger, detailing major elements, components, and systems of mechanical equipment and materials in relationship to other systems, installations and building components.

C. Coordination drawings shall include plans of each area and sections of congested area.

D. Coordination drawings shall:
   1. Indicate the proposed locations of any piping, ductwork, equipment and materials relating to the following:
      a. Exterior wall and foundation penetrations
      b. Equipment pads and bases
      c. Clearances for installing, servicing and maintaining equipment, including tube removal, filter removal and space for equipment disassembly required for periodic maintenance.
      d. Equipment service connections and support details.
      e. Ceiling plenums, chases, shafts, trenches, and other tight and congested spaces
      f. Piping system layout, include elbows, radii, and accessories.
   2. Indicate the proposed scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
   3. Include floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
   4. Include reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

1.10 RECORD DRAWINGS

A. During construction, the Contractor shall maintain a record set of contract drawings, and shall record on this set in colored pencil all deviations from the original in pipe, duct, or equipment sizes, locations, and other pertinent details.

B. Upon completion of the work, Contractor shall forward these marked prints to the Professional for review.

1.11 CODES, PERMITS, APPROVALS

A. All required local, state and utility company permits and approvals shall not be obtained by the Contractor. The design Professional shall submit to the Pennsylvania Department of Labor and Industry for all Construction permits. Fees do not apply.

B. All persons digging at the site shall notify PA ONE CALL at 1-800-272-1000.

C. All Plumbing work shall comply with all applicable provisions of the International Building Codes (IBC), latest edition adopted by the Commonwealth of Pennsylvania, including the International Plumbing Code (IMC).

D. All Plumbing work shall be subject to all provisions of the National Fire Code.

E. All work shall meet the requirements and standards of the several Utility Company(s) serving the project. Install and test backflow preventers in accordance with regulations of the serving utility company.

F. All heating work, pressure vessels, etc. shall comply with the latest revision of the regulations of the State of Pennsylvania, Department of Labor and Workforce Development.

G. All materials furnished shall meet the ASTM Specifications latest revisions.

I. All electrical work shall be in conformance with the latest edition of the National Electrical Code (NEC).

J. In all cases, the local Authority-Having-Jurisdiction (AHJ) has the right to impose a higher standard of care than the basic codes listed herein. The contractor shall be familiar with the requirements of and, if unsure, consult with the local AHJ, and make due allowance for more stringent stipulations if necessary. The contractor shall be responsible for all additional work and related costs to comply with the requirements of the local AHJ where such requirements differ from those listed in the basic building code(s).

1.12 MATERIALS AND EQUIPMENT

A. All materials and equipment shall be new, the best of their respective kinds, and suitable for the conditions and duties imposed on them at the building. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following sections.

B. All component parts of each item of equipment or device shall bear the manufacturer's nameplate, giving name of manufacturer, description, size, type, serial or model number, electrical characteristics, and any other imperative information in order to facilitate their maintenance or replacement. The nameplate of a subcontractor or distributor will not be acceptable.

C. All equipment requiring electrical service shall be UL labeled. If a UL label is not available from the manufacturer, when requested or required by the local authority having jurisdiction, the equipment shall be tested by an approved electrical testing company in accordance with NEC, and at no additional cost to the Client Agency. Submit data indicating compliance with standards prior to installation.

D. The contractor understands that:
   1. The Professional will use their own judgment in determining whether or not any materials, equipment or methods offered for review as an equivalent are equivalent to those specified.
   2. The decision of the Professional on all such questions of equivalency is final.
   3. Any acceptable material, equipment, and methods will be provided at no increases in cost to the Client Agency.

1.13 SUBMITTALS AND SHOP DRAWINGS

A. After receiving approval of the source of supply list; furnish catalog data, dimensional data, performance specifications, etc., in sufficient detail to properly identify and judge each item. Each item or equipment proposed shall be a standard product of the approved manufacturer.

B. Samples, drawings, specifications, catalogs, etc., submitted for review shall be dated, properly labeled indicating specific service for which material or equipment is to be used, section and article number of specifications governing, Contractor's name, and name of job.

C. Review of shop drawings or samples by the Professional shall not relieve the Contractor of responsibility for any deviation from the requirements of the contract documents. Deviations from the contract documents will only be allowed if all the following are satisfied:
   - The Contractor has informed the Professional in writing of all deviations at the time of submission,
   - The Contractor has noted the deviation on the shop drawings,
   - The Professional has acknowledged, in writing, the specific deviation.

D. In any event, the Professional's review shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.

E. No materials or equipment shall be purchased, delivered to the site, or installed until they have been reviewed by the Professional. Review of any submittal shall not relieve the Contractor of responsibility for deviation from the drawings or specifications, nor shall it relieve the Contractor from errors in the submittals. Dimensions and quantities shall, in all cases, be the complete responsibility of the Contractor.

F. Subsequent to the Professional's review of a submittal, it shall be marked with one or more comments as defined below:

- No Exceptions Taken: The contractor may proceed using the reviewed material,
- Note Markings: The contractor may proceed using the reviewed material provided corrective action is taken on all comments noted on the submittal,
- Comments Attached: Same as "Note Markings", except that comments have been noted on a supplemental attachment,
- Contractor Confirm: The contractor shall respond in writing to all comments including confirmation that corrective action will be taken on all comments noted prior to proceeding with the work,
- Resubmit: The contractor shall respond to all comments noted, revise shop drawings accordingly, and resubmit for review,
- Rejected: The proposed material or equipment does not comply with the requirements of the contract documents and may not be used for this project.

G. Upon receipt of written notice from the Professional that the material, equipment, or methods have been reviewed and marked "no exceptions taken", "Note Markings", or "Comments Attached", the Contractor may proceed with the reviewed material, equipment, or methods. The Contractor assumes full responsibility for and shall make, at no expense to the Client Agency, all changes or adjustments in construction that may result by the use of such approved materials, equipment or methods, including electrical and other services provided under other divisions of this specification. In the event of any adverse decisions by the Professional, no claim of any sort shall be made or allowed against the Professional or the Client Agency.

H. If material or equipment is installed prior to receipt by the contractor of submittals marked "no exceptions taken", "note markings", or "comments attached", the Contractor shall be liable for its removal and replacement at no extra cost to the Client Agency.

I. Sufficient sets shall be submitted to allow two (2) copies to be retained by the Professional.

J. Materials and equipment requiring submittals are listed in each section of these specifications.

1.14 CONTRACTORS RESPONSIBILITY - SUBMITTALS

A. The Contractor shall submit a letter with each submittal forwarded to the Professional's office for review certifying that they have personally reviewed the material submitted and found it to be satisfactory for this project. This certification shall cover dimensional checking as well as cross checking with the Architectural, HVAC, and/or Electrical documents to insure that no changes will be required in other contracts.

B. Any material submitted to the Professional's office without this Contractor's certification will be returned without action.

C. Whenever alternate equipment is submitted, it shall be accompanied by a 1/4" - 1'0" scale drawing of the mechanical equipment room showing the alternate equipment, all clearances, etc. Submittals without this information will be returned without review or comment.

1.15 SUBSTITUTION OF EQUIPMENT

A. Substitution of equipment of makes other than those specified, after receipt of the bid, will be approved by the Professional only if:
- The equipment proposed for substitution is equivalent or superior to equipment named in terms of construction, efficiency, and utility, and
- That the equipment named in the specifications cannot be delivered to the job in time to complete the work in proper sequence to work of other Contractors, due to conditions beyond control of the Contractor.

B. To receive consideration, requests for substitutions must be accompanied by documentary proof of equivalence or difference in price and delivery, if any, in form of certified quotations from suppliers of both specified and proposed equipment.

C. In case of a difference in price, the Client Agency shall receive all benefit of the difference in cost involved in any substitution, and the contract altered by change order to credit Client Agency with any savings so obtained.

1.16 PERFORMANCE OF EQUIPMENT

A. All materials, equipment, and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity. No approval either written or verbal of any drawings, descriptive data or samples of such material, equipment, and/or appurtenances shall relieve the Plumbing Contractor of his responsibility to turn over the same to the Client Agency in perfect working order at the completion of the work.

B. If the operation, capacity, or performance of any material, equipment, or appurtenance, does not comply with the drawings and/or specification requirements, or is damaged

prior to acceptance by the Client Agency, respective item(s) will be considered defective. All defective items shall be removed and replaced with proper and acceptable materials, equipment, and/or appurtenances, or, put in proper and acceptable working order, satisfactory to the Professional, prior to final payment without additional cost to the Client Agency.

1.17 GUARANTY/WARRANTY

A. Materials, equipment, and systems furnished under these specifications shall be guaranteed against defects in material, design, and workmanship.

B. Contractor shall provide a list of equipment and the warranty periods as a submittal that will be reviewed by the Client Agency and the design team.

C. The guarantee period shall extend until the later of:
- A period of one (1) year from the date of final acceptance,
- Eighteen (18) months from the date of initial start-up.

D. The Contractor shall replace any material or equipment that comprises a part of any system that develops any defect during the guarantee period, at their expense.

E. Contractor shall turn over to the Client Agency all warranties and guarantees upon completion and final acceptance of project.

1.18 OPERATING AND MAINTENANCE MANUALS

A. Contractor shall submit operating and maintenance instructions for all equipment furnished by them.

B. Maintenance and operating instructions shall be manuals prepared by the various manufacturers for the specific equipment furnished. Manuals shall cover such items as start-up procedures, trouble-shooting, periodic maintenance, etc. Advertising literature or catalogs will not be acceptable in this connection.

C. Three (3) sets of the above material shall be submitted to the Professional for review and approval.

D. Final job acceptance date shall be the date stamped on the operating and maintenance instructions and the guarantee period shall generally extend from that date.

1.19 CHARTS

A. Provide permanent type charts, framed under glass, mounted where directed as follows:
   1. Valve charts giving valve use, system, and number on tag attached to valve.
   2. Equipment and motor list giving system, equipment designation, and motor horsepower.
   3. Automatic temperature control schematics and sequences of operation.
   4. Lubrication instructions for all equipment giving type of lubricant and frequency.
   5. Service organizations with normal and emergency telephone numbers.
   6. Abbreviated operating instructions for all mechanical systems.

PART 2 - PRODUCTS

2.1 VIBRATION CONTROL

A. Vibration isolation devices shall be provided in accordance with Chapter 47, Table 42 ("Selection Guide for Vibration Isolation") of the American Society of Heating, Refrigerating, and Air-conditioning Engineers, Inc.'s (ASHRAE) 2003 Application Handbook.

2.2 ACCESSIBILITY

A. Locate all equipment that must be serviced, operated, or maintained, in fully accessible locations. Equipment shall include, but not be limited to water heaters, coils, valves, motors, controllers, drain points, traps, strainers, etc. The contractor shall rework, at their expense, any equipment that is deemed inaccessible to the satisfaction of the Professional.

B. Where accessible or removable ceilings are provided, ceiling panels or tiles may be removed to serve as access panels.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE

A. Contractor shall familiarize themselves with all drawings and documents for the entire project.

B. By virtue of submitting a proposal, Contractor accepts the fact that tight conditions will likely occur at various locations. No extras will be approved for necessary variations and/or adjustments that may be required to resolve interferences.

C. Details of proposed changes found necessary by field conditions or other causes shall be submitted to the Professional for approval before proceeding with any such change.

D. No extra compensation will be allowed on account of a difference between actual dimensions and measurements at the site and those indicated on the drawings.

3.2 DIMENSIONS OF EXISTING STRUCTURES

A. Where the dimensions and locations of existing structures are of critical importance in the installation or connection of new work, verify such dimensions and locations in the field before the fabrication of any material or equipment that is dependent on the correctness of such information.

B. This stipulation applies specifically to existing sewer lines, manholes, etc. Establish exact invert of existing lines before beginning installation of any new work.

3.3 LINES, GRADES, AND MEASUREMENTS

A. Make all measurements and check all dimensions necessary for the proper construction of the work called for by the drawings and specifications. During the prosecution of the work, make all necessary measurements to prevent misfitting in said work, and for the accurate construction of the entire work.

3.4 COORDINATION

A. Plumbing Contractor shall plan all sequences of their portion of the project so that the work proceeds with a minimum of interference with other trades. They shall cooperate with all other Contractors in coordinating the locations of piping, ducts, etc., with lighting fixtures, structural members, sprinkler heads, etc.

B. Plumbing Contractor shall check all project drawings prior to installing any equipment, pipes, ducts, etc. Any conflicts that become apparent as a result of cross checking drawings shall be resolved with the Professional prior to any work being done. Minor adjustments in location, size, and type of materials necessary to work out any interference shall be made at no extra cost. Being installed "first" in any particular situation will not be considered a factor in the proper resolution of a conflict.

3.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification; adequately packaged and protected to prevent damage during shipment, storage, and handing.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. If any materials or equipment are found to be damaged or in poor condition at the time installation, the Professional may, at their discretion, order the Contractor to furnish and install new materials or equipment at no additional expense to the Client Agency.

3.6 PROTECTION

A. Protect all work, equipment, and materials at all times. All pipe openings shall be capped and plugged during installation.

B. All necessary precautions shall be taken to prevent damage to any work, materials, or equipment furnished by the Contractor. The Contractor shall be held responsible for all damage incurred to his work, materials, and equipment until his portion of the project is fully and finally accepted.

C. Plumbing Contractor shall adequately cover and protect all plumbing fixtures as may be necessary until completion of the work. Plumbing Contractor shall be responsible for damage or breakage to fixtures and shall make good such damaged items at no cost to the Client Agency.

D. Drainage lines shall be kept free of dirt, concrete, or debris during the course of construction. The contractor shall correct any blockages resulting from the above.

E. Carefully make-up piping or accessories having polished, plated, or finished surfaces to avoid scarring. Protect fixtures or equipment having finished surfaces before, during, and after installation with special protective coatings for this purpose.

F. Do not install exposed polished metal fittings, parts, and devices, until adjoining tile or masonry has been finally acid cleaned.

G. All equipment, devices, controls, and motors shall be tightly covered and protected during construction up to the time of operation. Protection shall be arranged and of such design to prevent damage by infiltration of dust, dirt, debris, moisture, chemicals,

or water. Minimum protection shall be by covering with transparent plastic sheeting to the satisfaction of the Professional.

H. The Plumbing Contractor shall likewise protect from damage all materials, new and existing, turned over to them by others (including the Client Agency) for installation. The Contractor shall replace any material that becomes damaged at their expense.

3.8 CUTTING AND PATCHING

A. Plumbing Contractor shall do all cutting necessary to properly install their materials, except as noted hereafter. This shall include cutting of existing concrete floors and walls. Cutting and patching of every nature required in connection with this Contract shall be done with mechanics experienced in their respective lines of work. All patching shall match adjacent finishes.

B. All cutting in the building shall be done with great care so as not to leave an unsightly surface that may not be concealed by plates, escutcheons, or other normal concealing construction. If such unsightly conditions occur through fault of the Contractor, they shall be required to correct such deficiencies to the satisfaction of the Professional.

C. All holes for piping shall be core drilled through existing concrete floors and walls.

D. No cutting of structural members shall be done until approval has been received from the Professional.

E. Plumbing Contractor(s) shall do all patching required to restore the substrate to a condition that will readily receive new finishes. The General Contractor shall provide all new finishes; tile, plaster, paint, etc.

F. Plumbing Contractor shall provide the General Contractor or any other Contractors, which may be affected by his work, locations, and sizes of chases, sleeves, and openings required for installation of pipes, ducts, and other equipment. This information shall be presented to the General Contractor previous to pouring concrete or erecting walls to avoid unnecessary cutting and patching.

G. If openings are omitted or are incorrect through failure of the contractors to follow these instructions, the respective Contractors shall, at their own expense, engage the trade which originally installed the work, to cut and patch to the satisfaction of the Professional.

3.9 EQUIPMENT INSTALLATION AND CONNECTIONS

A. All equipment shall be installed and connected in accordance with the best engineering practice and in accordance with manufacturer's instructions and recommendations. Auxiliary piping, valves, and electric connections recommended by the manufacturer or required for proper operation shall be provided.

B. Any conflicts between the installation instructions indicated on the contract documents and the manufacturer's instructions and recommendations shall be brought to the attention of the Professional for resolution. The Professional's decision as to the final equipment installation and connections is final and any modifications necessary to obtain such an installation shall be made at no expense to the Client Agency.

END OF SECTION 230000

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of Contract”, “Special Conditions” and “Division1 – General Requirements” form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Equipment installation requirements common to equipment sections.
   4. Painting and finishing.
   5. Supports and anchorages.

1.4 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, 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 chases.

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 following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

H. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Attend construction phase coordination meeting.

B. Attend testing, adjusting, startup and balancing review and coordination meeting.

1.6 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.

B. Welding certificates.

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.

1.8 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 to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.9 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the manufacturers specified. Approved equal products are acceptable.

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 23 piping Sections for special joining materials not listed below.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 and Division 23 specifying 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 indicated to be exposed at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Verify final equipment locations for roughing-in.

J. 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 Division 22 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. 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.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

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 plumbing 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.

3.5 PAINTING

A. Quality Assurance
   1. MPI Standards:
      a. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
      b. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Products
   1. Paint, General
      a. Material Compatibility:
         1) Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
         2) For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
      b. Colors: Yellow.
   2. Metal Primers
      a. Alkyd Anticorrosive Metal Primer: MPI #79.
         1) VOC Content: E Range of E1.
   3. Quick-Drying Enamels
      a. Quick-Drying Enamel (Semigloss): MPI #81 (Gloss Level 5).
         1) VOC Content: E Range of E1.

C. Execution
   1. Examination
      a. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
      b. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
      c. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
      d. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

2. Preparation And Application
   a. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
   b. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.
      1) Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
   c. 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.
   d. 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.

END OF SECTION 220500

SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. Section Includes:
1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft Inc.
   2. Trerice, H. O. Co.
   3. WATTS.
   4. Equal as approved by Professional.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flo Fab Inc.
      b. Trerice, H. O. Co.
      c. Weiss Instruments, Inc.

d. Equal as approved by Professional.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass.
8. Stem: Aluminum and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ernst Flow Industries.
      b. WATTS.
      c. Weiss Instruments, Inc.
      d. Equal as approved by Professional.
   2. Standard: ASME B40.200.
   3. Case: Plastic; 7-inch nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue or red organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
   7. Window: Glass.
   8. Stem: Aluminum, brass, or stainless steel and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
   10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 THERMOWELLS

A. Thermowells:
   1. Standard: ASME B40.200.
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
   10. Lagging Extension: Include on thermowells for insulated piping and tubing.
   11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Ametek U.S. Gauge.
      b. Trerice, H. O. Co.
      c. WATTS.
      d. Equal as approved by Professional.

   2. Standard: ASME B40.100.
   3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
   4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   6. Movement: Mechanical, with link to pressure element and connection to pointer.
   7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
   8. Pointer: Dark-colored metal.
   9. Window: Glass.
   10. Ring: Stainless steel.

11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Ametek U.S. Gauge.
b. Trerice, H. O. Co.
c. Weiss Instruments, Inc.
d. Equal as approved by Professional.

2. Standard: ASME B40.100.
3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install valve and snubber in piping for each pressure gage for fluids.

I. Install thermometers in the following locations:
   1. Inlet and outlet of each water heater.
   2. Inlets and outlets of each domestic water heat exchanger.
   3. Inlet and outlet of each domestic hot-water storage tank.
   4. Inlet and outlet of each remote domestic water chiller.

J. Install pressure gages in the following locations:
   1. Building water service entrance into building.
   2. Inlet and outlet of each pressure-reducing valve.
   3. Suction and discharge of each domestic water pump.

K. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

L. Adjust faces of meters and gages to proper angle for best visibility.

3.2 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
   1. Liquid-filled bimetallic-actuated type.
   2. Metal case, industrial-style, liquid-in-glass type.

B. Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
   1. Liquid-filled, bimetallic-actuated type.

2. Metal case, industrial-style, liquid-in-glass type.

C. Thermometer stems shall be of length to match thermowell insertion length.

3.3 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.4 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:
1. Liquid-filled, direct-mounted, metal case.

2. Sealed direct-mounted, plastic case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
1. Liquid-filled, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with EPDM self-sealing rubber inserts.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 200 psi.

B. Scale Range for Domestic Water Piping: 0 to 200 psi.

END OF SECTION 220519

SECTION 220523.12

BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of Contract”, “Special Conditions” and “Division1 – General Requirements” form a 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. Brass ball valves.
   2. Bronze ball valves.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   3. ASME B16.18 for solder-joint connections.
   4. 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.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
1. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:
1. Include 2-inch stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, One-Piece:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. WATTS.
c. QSM.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Forged brass or bronze.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Brass or stainless steel.
h. Ball: Chrome-plated brass or stainless steel.
i. Port: Full.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, One-Piece:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Flow Controls; Conbraco Industries, Inc.
      b. WATTS.
      c. QSM.
      d. Equal as approved by the professional.

   2. Description:
      a. Standard: MSS SP-110.
      b. CWP Rating: 400 psig.
      c. Body Design: One piece.
      d. Body Material: Bronze.
      e. Ends: Threaded.
      f. Seats: PTFE.
      g. Stem: Bronze.
      h. Ball: Chrome-plated brass.
      i. Port: Full.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.3 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Brass ball valve, one piece with full port.
   3. Bronze ball valve, one piece with full port and bronze trim.

END OF SECTION 220523.12

SECTION 220523.13

BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Iron, single-flange butterfly valves.
   2. Chainwheels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   3. Certification that products comply with NSF 61 Annex G and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.1 for flanges on iron valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   3. ASME B31.9 for building service piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:
1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, handlever, or stem; of size and with chain for mounting height, according to "Valve Installation" Article.

G. Valves in Insulated Piping: With 2-inch stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated ductile iron.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze or ductile-iron disc.

END OF SECTION 220523.13

SECTION 220523.14

CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze swing check valves.
   2. Iron swing check valves.
   3. Iron swing check valves with closure control.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.
   1. Certification that products comply with NSF 61 and NSF 372.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.9 for building services piping valves.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.

c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Crane; a Crane brand.
e. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Composition.
g. Seat Ring: Bronze.

h. Disc Holder: Bronze.
i. Disc: PTFE.
j. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane; a Crane brand.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed exterior lever and spring.

B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Apollo Flow Controls; Conbraco Industries, Inc.
b. NIBCO INC.
c. Stockham; a Crane brand.
d. Equal as approved by the professional.

2. Description:
a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A126, gray iron with bolted bonnet.
e. Ends: Flanged or threaded. See valve schedule articles.
f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed exterior lever and weight.

PART 3 - EXECUTION

3.1 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install swing check valves for proper direction of flow in horizontal position with hinge pin level.

3.2 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. End Connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. If valve applications are not indicated, use the following:
1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze swing check valves bronze or nonmetallic disc, Class 125, with soldered or threaded end connections.
   2. Bronze swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron swing check valves with metal or nonmetallic-to-metal seats, Class 125, with threaded or flanged end connections.
   2. Iron swing check valves with closure control, lever and weight, Class 125, with threaded or flanged end connections.

END OF SECTION 220523.14

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Thermal hanger-shield inserts.
   4. Fastener systems.
   5. Pipe-positioning systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Pipe Welding Qualifications: Qualify procedures and operators according to "2015 ASME Boiler and Pressure Vessel Code, Section IX."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe and Tube Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C 533, Type I calcium silicate with 100-psig, ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. B-line, an Eaton business.
      b. Hilti, Inc.
      c. MKT Fastening, LLC.
      d. Equal as approved by the professional.

   2. Indoor Applications: Zinc-coated or stainless steel.
   3. Outdoor Applications: Stainless steel.

2.6 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B 221.

B. Carbon Steel: ASTM A 1011/A 1011M.

C. Structural Steel: ASTM A 36/A 36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A 240/A 240M.

E. Grout: ASTM C 1107/C 1107M, 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 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal 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 that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:
1. Attach clamps and spacers to piping.
   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. 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. Thermal Hanger Shields: Install with insulation of 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 bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are required.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A 780/A 780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, 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 little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
   7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
   10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
   11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. 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.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. 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 occurs and vertical adjustment is unnecessary.
21. 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, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
   2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches 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.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    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.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548

VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restraining braces and cables.
12. Steel and inertia, vibration isolation equipment bases.

1.4 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.5 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint is not required for this project.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, required to select vibration isolators and for designing vibration isolation bases.
   2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Welding certificates.

D. Qualification Data: For professional engineer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

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

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ace Mountings Co., Inc.
2. Mason Industries.
3. Vibration Eliminator Co., Inc.
10. Equal as approved by the professional.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings.
1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded

element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Limit-stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral snubbers.
   1. Housing: Ductile-iron or steel housing to provide all-directional restraint.
   2. Base: Factory drilled for bolting to structure.
   3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
   1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- thick neoprene. Include steel and neoprene

vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amber/Booth Company, Inc.
2. Mason Industries.
3. Vibration Eliminator Co., Inc.
10. Equal as approved by the professional.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
2. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
2. Include supports for suction and discharge elbows for pumps.
3. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
4. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

5. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.3 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of sprint isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.4 PLUMBING VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported or Suspended Equipment: .
   1. Equipment Location: Basement Mechanical Rooms.
   2. Pads:
      a. Material: Neoprene.
      b. Thickness: 1/4".
      c. Number of Pads: 1 thick.
   3. Isolator Type: Spring.
   4. Minimum Deflection: 1/2".

END OF SECTION 220548

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Brady Corporation.
      b. LEM Products Inc.
      c. Seton Identification Products.
      d. Equal as approved by the professional.

   2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   3. Letter Color: White.
   4. Background Color: Black.

5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. LEM Products Inc.
3. Seton Identification Products.
a. Equal as approved by the professional.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Red.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
2. LEM Products Inc.
3. Seton Identification Products.
a. Equal as approved by the professional.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

PART 3 - EXECUTION

3.1 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.2 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:
   1. Domestic Water Piping
      a. Background: ANSI Z535.1 Safety green.
      b. Letter Colors: White.
   2. Air conditioning Condensate Piping
      a. Background: ANSI Z535.1 Safety blue.
      b. Letter Colors: White.

END OF SECTION 220553

SECTION 220719

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:
1. Domestic water piping.
2. Domestic recirculating hot-water piping.
3. Air-conditioning condensate piping.

1.3 ACTION SUBMITTALS

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

B. Sustainable Design Submittals:
1. Provide submittals for adhesives, mastics and sealants.

C. Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Aeroflex USA, Inc.
      b. Armacell LLC.
      c. K-Flex USA.
      d. Equal as approved by the professional.

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Johns Manville; a Berkshire Hathaway company.
b. Knauf Insulation.
c. Manson Insulation Inc.
d. Owens Corning.
e. Equal as approved by the professional.

2. Type I, 850 Deg FMaterials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. Ramco Insulation, Inc.
b. Equal as approved by the professional.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Aeroflex USA, Inc.
b. Armacell LLC.
c. Foster Brand; H. B. Fuller Construction Products.
d. Equal as approved by the professional.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.

d. Equal as approved by the professional.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
d. Equal as approved by the professional.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Dow Corning Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Speedline Corporation.
d. Equal as approved by the professional.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Knauf Insulation.
d. Equal as approved by the professional.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Knauf Insulation.
   d. Equal as approved by the professional.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 SEALANTS

A. Joint Sealants for Cellular-Glass Products:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products.
      c. Mon-Eco Industries, Inc.
      d. Equal as approved by the professional.

   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 100 to plus 300 deg F.
   5. Color: White or gray.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Childers Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products
      c. Equal as approved by the professional.

   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Foster Brand; H. B. Fuller Construction Products.
      b. Foster Brand; H. B. Fuller Construction Products
      c. Vimasco Corporation.
      d. Equal as approved by the professional.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Johns Manville; a Berkshire Hathaway company.
      b. P.I.C. Plastics, Inc.
      c. Speedline Corporation.
      d. Equal as approved by the professional.

   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.
c. Knauf Insulation.
d. Equal as approved by the professional.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Avery Dennison Corporation, Specialty Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.
c. Knauf Insulation.
d. Equal as approved by the professional.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Compac Corporation.
   b. Ideal Tape Co., Inc., an American Biltrite Company.
   c. Venture Tape.
   d. Equal as approved by the professional.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division.
   b. Ideal Tape Co., Inc., an American Biltrite Company.
   c. Knauf Insulation.
   d. Equal as approved by the professional.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.10 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ITW Insulation Systems; Illinois Tool Works, Inc.
   b. RPR Products, Inc.
   c. Equal as approved by the professional.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed, stainless steel or 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. C & F Wire.
   b. Equal as approved by the professional.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
      a. For below-ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.3 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. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

D. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
   5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

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 INSTALLATION OF MINERAL-FIBER PREFORMED PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with 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. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install 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 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.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.10 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water: Insulation shall be one of the following:
1. Flexible Elastomeric: 1-1/4” & smaller = 1/2 inch thick.
2. Flexible Elastomeric: 1-1/2” & larger = 1 inch thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/4” & smaller = 1/2 inch thick.
4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” & larger = 1 inch thick.

B. Domestic Hot and Recirculated Hot Water: Insulation shall be one of the following:
1. Flexible Elastomeric: 1-1/4” & smaller = 1 inch thick.
2. Flexible Elastomeric: 1-1/2” & larger = 1-1/2 inch thick.
3. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/4” & smaller = 1 inch thick.
4. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2” & larger = 1-1/2 inch thick.

C. Air Conditioning Condensate in finished areas and above ceilings: Insulation shall be one of the following:
1. Flexible Elastomeric: 1/2 inch thick.
2. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

END OF SECTION 220719

SECTION 220800

PLUMBING SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specification sections "General Conditions", "Special Requirements" and "General Requirements" form a 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. General provisions and other plumbing systems are specified in other Sections of Division 22.

B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 22 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 22 shall be familiar with the commissioning plan issued by the Commissioning Agent as it applies to the work of Division 22 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the plumbing equipment and systems provided by this Division.

D. This Section covers plumbing systems commissioning, as required to demonstrate that the equipment and systems of Division 22 are ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, The Client Agency’s operating personnel training, and preparation of record drawings.

E. This section does not alter the equipment start-up and testing requirements indicated in Division 22 sections of the building specifications. This section is to help define/supplement the requirements of Section 01 9000 where applicable.

1.3 QUALITY ASSURANCE

A. The plumbing Prime Contractor shall identify a plumbing commissioning supervisor. The plumbing commissioning supervisor should have a minimum of ten years experience in plumbing contracting. The plumbing commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The plumbing commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outline by the commissioning agent. The plumbing commissioning supervisor shall assist the Commissioning Agent in coordinating and executing the required commissioning activities.

1.4 PLUMBING PRIME CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price.

B. Assemble all record drawings and all records of Code authority inspections and approvals. Review operation and maintenance information and as-built drawings and obtain all documentation from tests for review. Document warranty start and dates.

C. The plumbing commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing and commissioning activities with the Prime Contractor. Specific requirements of the plumbing Prime Contractor are identified in this Section. The Commissioning Agent shall conduct independent verification of installation, pre-functional, start-up and functional testing.

D. Plumbing commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:

1. Construction Phase

a. Attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early

construction and increase in frequency to weekly during the start-up, prefunctional and functional testing phases. Assure that all Prime Contractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.

b. Report in writing to the CA at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies and proposed resolution and schedule.

c. Provide the Commissioning Agent with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.

d. Provide documentation to the Commissioning Agent for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any The Client Agency-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of The Client Agency to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.

e. Develop and submit to the Commissioning Agent a complete startup and initial checkout plan using manufacturer’s start-up procedures for review prior to equipment or system startup. The commissioning agent shall conduct their own pre-functional testing check in parallel with the Prime Contractor.

f. Review the commissioning agent's pre-functional checksheets and sign-off on the appropriate areas when Prime Contractor and Prime Contractors are complete. The prefunctional test sheets will be developed by the commissioning agent. Only when each portion of the pre-functional test sheet is signed off will the Prime Contractor be able to move onto the next phase of the start-up and check-out.

g. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Agent for review.

h. Assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

i. Commissioning Agent shall prepare the specific functional test procedures as specified herein. The Prime Contractor shall review the Commissioning Agent's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

j. Commissioning agent shall prepare a preliminary schedule for Division 22 commissioning activities for use by the Prime Contractor and shall update the schedule as appropriate. The Prime Contractor shall update the commissioning activities and notify any delays in the progress meetings. The Prime Contractor shall notify the Commissioning Agent during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.

k. Plumbing equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the commissioning agent as specified in other Sections of Division 22.

l. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Agent.

m. Correct current Design Engineer punch list and Commissioning Agent deficiency items before functional performance testing can begin.

n. The Commissioning Agent shall generate the functional testing procedure and record to the plumbing Prime Contractor. The plumbing Prime Contractor shall review and provide support to the functional testing process or applicable systems. Prime Contractor shall open and close disconnects and switches normal and emergency power requirements as directed by the Commissioning Agent and the functional testing procedures.

o. Report in writing to the CA at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, prefunctional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

2. Acceptance Phase. Prime Contractor shall assist and cooperate with the Commissioning Agent in the commissioning process by:

a. Putting all plumbing equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.

b. For a given system, have all required prefunctional checklists, calibrations, startup and selected functional tests approved by the Commissioning Agent prior to beginning the test and balance process.

c. Providing skilled technicians to execute starting and operation of equipment.

d. The Commissioning Agent will conduct functional performance testing. The Prime Contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.

e. The Commissioning Agent will require full and part load performance verifications as well as simulated testing requirements. The Prime Contractor shall be prepared to operate different components of various systems during the functional testing.

f. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Agent and Design Engineer.

g. Prepare O&M manuals according to the Prime Contractor Documents, including clarifying and updating the original design intention to as-built conditions.

h. Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and Prime Contractor-generated coordination drawings.

i. Provide specified training of the Client Agency's operating personnel in accordance with the commissioning agent's overview and outline.

j. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

3. Warranty Period. During the warranty period, the Prime Contractor shall:

a. Be available during seasonal or deferred functional performance testing conducted by the Commissioning Agent, according to the specifications.

b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 - PRODUCTS

2.1 SYSTEMS TO BE COMMISSIONED

A. The following are systems to be commissioned.

1. Domestic Hot Water Systems

2.2 TEST EQUIPMENT

A. All standard testing equipment required to the plumbing portion startup, initial checkout shall be provided by the Prime Contractor responsible for the equipment or system being tested.

B. The Commissioning Agent shall perform their own system verification and performance check-out. The commissioning agent shall provide their own calibrated equipment as required for this testing.

C. All testing equipment associated with functional performance verification and point-to-point required by the commissioning agent shall be the responsibility of the commissioning agent.

D. Special equipment, tools and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the Commissioning Agent by the installing Prime Contractor and shall become the property of the Client Agency at project completion as indicated in the specification.

E. Proprietary test equipment and software required by any manufacturer for programming and / or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide test equipment, demonstrate its use and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of The Client Agency upon successful completion of the commissioning process as required in the specifications.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Plumbing Prime Contractor shall provide submittal documentation relative to commissioning as required in this Section Part 1.

3.2 STARTUP PLAN AND PREFUNCTIONAL TESTING

A. The plumbing Prime Contractor shall be responsible for the installation of complete systems and systems, fully functional, meeting the design objectives of the Contract Documents. Follow the approved start-up, initial checkout, and prefunctional testing

procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the Commissioning Agent.

B. Pre-functional test forms as written by the Commissioning Agent shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing to may proceed without delays. Sampling strategies shall be used on lower level components of equipment for pre-functional testing. The pre-functional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The plumbing Prime Contractor shall sign off on the Commissioning Agent's pre-functional test sheets that they are complete and the system is ready. The Commissioning Agent will verify and conduct their own independent verification and start-up in parallel to the Prime Contractor's verification. Any deficiencies identified during this process shall be noted and reviewed by the Prime Contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the Commissioning Agent.

C. The following procedures shall apply to all equipment and systems to be commissioned.

1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and prefunctional testing plans for all equipment. The primary role of the Commissioning Agent in this process shall be to review the installation for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all Prime Contractors, shall the equipment be started-up by the Prime Contractor. Equipment and systems to be commissioned are identified in this Section Part 2.

2. The start-up and initial checkout plan shall consist of the following as a minimum:

a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting

the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

b. First-run checklist for equipment, to in accordance with the manufacturer recommendations and pre-functional check list determined by the Commissioning Agent.

3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.

D. The Commissioning Agent shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.

E. Two weeks prior or startup, the Prime Contractor shall schedule startup and checkout with Commissioning Agent. The execution of the startup and checkout shall be directed and performed by the Prime Contractor, in accordance with manufacturer's published procedures and with the approved procedures. The Commissioning Agent shall be present for the Prime Contractor's required startup and checkout of all systems and equipment to be commissioned.

F. All Prime Contractor responsible start-up, checkout forms shall be completed and submitted to the Commissioning Agent for review.

3.3 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full and part load requirements. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include; testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation. Proper responses such as power failures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the

testing, conducts the testing and documents the testing. Each Prime Contractor is required to supply personnel to assist during the functional performance testing where applicable.

B. No system, equipment or component thereof shall be tested until the Prime Contractor and has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the Commissioning Agent. Functional Performance Verification will not be conducted until a written notice of completion by the Prime Contractor confirming that the system is ready for FPV. The air balancing and water balancing must be complete and the controls must be debugged prior to the performance verification.

C. Functional testing shall be conducted by the contract with assistance, coordination and documentation by the commissioning agent. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.

D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or systems at the discretion of the CA. Beginning system testing before full completion shall not relieve the Prime Contractor from fully completing the system, including all prefunctional checklists.

E. The Prime Contractor shall provide personnel to operate the systems while functional performance testing is commencing.

F. The Prime Contractor shall review the commissioning functional performance testing procedure supplied by the commissioning agent. After functional testing commences, the Prime Contractor and the commissioning agent shall sign the functional test record and provide The Client Agency a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.

G. All Functional Testing must be completed and approved by the Commissioning Agent before the project will be considered substantially complete.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. The Commissioning Agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to Prime Contractor within two days of test completion. The Commissioning Agent shall review the Prime Contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the Prime Contractor. The Commissioning Agent shall work with the Prime Contractor and others as necessary, to correct and retest deficiencies or uncompleted items. The Prime Contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CA as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the Commissioning Agent shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and a deficiency is identified, the Commissioning Agent shall discuss the issue with the executing Prime Contractor and the commissioning team.

1. When there is no dispute of the deficiency and the Prime Contractor accepts responsibility for correcting it, the Commissioning Agent shall document the deficiency and the Prime Contractor's response and intentions and the testing shall proceed, if possible. Corrections of minor deficiencies identified may be made by the Prime Contractor during the functional performance testing, at the discretion of the Commissioning Agent. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.

2. When the identified deficiency is corrected, the Prime Contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, the Commissioning Agent shall document the deficiency and the Prime Contractor's response, and provide a copy to the Prime Contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved. Final interpretive authority shall be by the Design Engineer. Final acceptance authority shall be The Client Agency.

C. During the functional performance testing of multiple units of similar equipment, the CA will test all of the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the Commissioning Agent. In such case, the Prime Contractor shall provide the Commissioning Agent with the following:

1. Within one week of notification from the Commissioning Agent, the Prime Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Commissioning Agent within two weeks of the original notice.

2. Within two weeks of the original notification, the Prime Contractor shall provide the Commissioning Agent and the Design Engineer a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.

3. When approved, two examples of the proposed solution shall be installed by the Prime Contractor and the Commissioning Agent shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the Commissioning Agent shall

recommend the acceptance or disapproval of the proposed solution to The Client Agency.

4. Upon acceptance of the proposed solution by the Client Agency, the Prime Contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.

D. Cost of Retesting

1. The cost for Commissioning Agent personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the Prime Contractor.

2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the Commissioning Agent and Prime Contractor shall direct the retesting of the equipment once at "no charge" for their time. However, all costs for any subsequent retesting shall be the responsibility of the Prime Contractor.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party.

3.5 TRAINING OF CLIENT AGENCY PERSONNEL

A. The plumbing commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The Commissioning Agent shall oversee the content and adequacy of the training of the Client Agency personnel.

B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from The Client Agency on which operating personnel shall be instructed in each system.

Proposed training schedules, materials, and lesson plans shall be submitted to the Commissioning Agent for review of the content and adequacy of the training of The Client Agency personnel for commissioned equipment or systems.

C. Training responsibilities shall include:

1. Provide the Commissioning Agent with training plan one week before the planned training.

2. Provide designated Client Agency personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing Prime Contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

6. The controls Prime Contractor shall attend sessions other than the controls training, for each type of equipment controlled by the Building Automation System, to discuss the interaction of the BAS as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

3.6 WRITTEN WORK PRODUCTS

A. Written work products of the Prime Contractor shall consist of the start-up and initial checkout plan and the filled out start-up, initial checkout and prefunctional checklists.

END OF SECTION 220800

SECTION 221116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Copper tube and fittings.
   2. Piping joining materials.
   3. Transition fittings.
   4. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

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.

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. Comply with NSF 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions:
1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

F. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:
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:
    1) Elkhart Products Corporation; Industrial Division.
    2) NIBCO INC.
    3) Viega; Plumbing and Heating Systems.
    4) Equal as approved by the professional.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200 psig working-pressure rating at 250 deg F.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.4 PEX TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. IPEX USA LLC.
2. REHAU.
3. Uponor.
4. Equal as approved by the professional.

B. Tube Material: PEX plastic according to ASTM F876 and ASTM F877.

C. Fittings: ASTM F1960, cold expansion fittings and reinforcing rings.

D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 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:
      a. Matco-Norca.
      b. WATTS.
      c. Zurn Industries, LLC.
      d. Equal as approved by the professional.
   2. Standard: ASSE 1079.
   3. Pressure Rating: 150 psig.
   4. 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:
      a. Matco-Norca.
      b. WATTS.
      c. Zurn Industries, LLC.
      d. Equal as approved by the professional.
   2. Standard: ASSE 1079.
   3. Factory-fabricated, bolted, companion-flange assembly.
   4. Pressure Rating: 150 psig.
   5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Advance Products & Systems, Inc.
b. Central Plastics Company.
c. Pipeline Seal and Insulator, Inc.
d. Equal as approved by the professional.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Matco-Norca.
b. Precision Plumbing Products.
c. Victaulic Company.
d. Equal as approved by the professional.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install shutoff valve immediately upstream of each dielectric fitting.

C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

D. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. 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.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping to permit valve servicing.

I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

3.2 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

G. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
   2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.

d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.

f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm 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 three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.9 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
   1. Hard copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

END OF SECTION 221116

SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Vacuum breakers.
   2. Balancing valves.
   3. Strainers.
   4. Air vents.

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.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.5 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.

1.6 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. NSF Compliance
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

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:
a. Ames Co.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Plumbing Products Group; Wilkins Div.
d. Equal as approved by the professional.

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: Chrome plated.

B. Hose-Connection Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Watts Industries, Inc.; Water Products Div.
b. Woodford Manufacturing Company.
c. Zurn Plumbing Products Group; Light Commercial Operation.
d. Equal as approved by the professional.

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.

2.2 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ITT Industries; Bell & Gossett Div.
b. NIBCO INC.
c. Watts Industries, Inc.; Water Products Div.
d. Equal as approved by the professional.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: 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.

B. Cast-Iron Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ITT Industries; Bell & Gossett Div.
b. NIBCO INC.
c. Watts Industries, Inc.; Water Products Div.
d. Equal as approved by the professional.

2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Milwaukee Valve Company.

c. NIBCO INC.
d. Equal as approved by the professional.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.3 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
a. Strainers NPS 2 and Smaller: 0.033 inch.
b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.4 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.

2.5 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

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 water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.

F. Install air vents at high points of water piping.

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. Calibrated balancing 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. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

END OF SECTION 221119

SECTION 221316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
1. Copper tube and fittings.
2. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. A/C Condensate Gravity Piping: 10 ft. head of water.
   2. A./C Condensate, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 COPPER TUBE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   2. Cerro Flow Products, LLC.
   3. Wieland Copper Products, LLC.
   4. Equal as approved by the professional.

B. Copper Type DWV Tube: ASTM B306, drainage tube, drawn temper.

C. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

D. Hard Copper Tube: ASTM B88, Type L and Type M, water tube, drawn temper.

E. Soft Copper Tube: ASTM B88, Type L, water tube, annealed temper.

F. 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.

G. 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.

H. Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
   2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    a. Straight tees, elbows, and crosses may be used on vent lines.
3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    a. Reducing size of waste piping in direction of flow is prohibited.

K. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: Two percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow.

L. Install aboveground copper tubing in accordance with CDA's "Copper Tube Handbook."

M. Install force mains at elevations indicated.

N. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
    b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
2. Install drains in sanitary waste gravity-flow piping.
    a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.2 JOINT CONSTRUCTION

A. Join copper tube and fittings with soldered joints in accordance with ASTM B828. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42 clamps.
6. Install individual, straight, horizontal piping runs:
   a. 100 Ft. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52 spring hangers.

B. Install hangers for copper soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical runs of copper soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:
1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections in accordance with the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.5 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
      a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
      a. Expose work that was covered or concealed before it was tested.
   3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
      a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
      b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
      c. Inspect joints for leaks.
   4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
      a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
      b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
      c. Air pressure must remain constant without introducing additional air throughout period of inspection.
      d. Inspect plumbing fixture connections for gas and water leaks.
   5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
   6. Prepare reports for tests and required corrective action.

E. Test force-main piping in accordance with 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.
      a. 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.
   a. Isolate test source and allow to stand for four hours.
   b. 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.

3.7 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.8 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, A/C condensate gravity piping NPS 4 and smaller are to be the following:
   1. Copper Type DWV tube, copper drainage fittings, and soldered joints.

C. Aboveground A/C condensate force mains NPS 1-1/2 and NPS 2 (DN 40 and DN 50) are to be the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

END OF SECTION 221316

SECTION 223500

DOMESTIC-WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Semi-instantaneous, domestic-water heaters.
   2. Accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale and coordinated with all building trades.

B. Product Certificates: For each type of semi-instantaneous water heater from manufacturer.
   1. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Warranty Periods: From date of Substantial Completion.
      a. Semi-Instantaneous, Domestic-Water Heaters:
         1) Tank: Five years.
         2) Tube Coil: Five years.
         3) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

B. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

C. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61and NSF 372.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.2 SEMI-INSTANTANEOUS, DOMESTIC-WATER HEATERS

A. Semi-Instantaneous, Heating-Fluid-in-Coil, Packaged, Compact, Less than 100-Gal., Domestic-Water Heater:
   1. Manufacturer”
      a. Armstrong
      b. Cemline
      c. Patterson-Kelly
      d. Equal as approved by the professional.

2. Description: Factory-packaged assembly of shell, heat-exchanger coils, and specialties for heating domestic water with steam in coils.
3. Construction:
   a. Fabricate and label heat exchanger to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

4. Configuration: Vertical-stacked helically shaped coils.
5. Shell Materials: Carbon steel, copper-lined shell with 250- psigminimum working-pressure rating.
   a. Tappings: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2and Larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

6. Head: Cast iron, flanged and bolted to shell.
7. Heat-Exchanger Coil: Double wall, copper-nickel coils for domestic water. Include pressure rating equal to or greater than heating-fluid supply pressure.
8. Relief Valves: ASME rated and stamped for combination temperature- and pressure-relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting of less than working-pressure rating of heat exchanger. Select one relief valve with sensing element that extends into storage tank.
9. Miscellaneous Components: Strainers, steam-control valve, steam trap, valves, pressure gauge, thermometer, and piping.
   a. Exception: Steam trap is not required if manufacturer's written instructions direct that it not be used.

10. Stand: Factory fabricated on skid for floor mounting.
11. Insulation: Complying with ASHRAE/IES 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire shell and nozzle, except connections and controls.
12. Required Connections: Domestic cold water in; domestic hot water out; steam supply in; condensate return out.
13. Capacity and Characteristics:
    a. Domestic Water:
    b. Recovery: See plans.
       1) Hot-Water Temperature Setting: See plans.
       2) Pipe Size: See plans.
    c. Steam Supply:

1) Inlet Pressure: See plans.
2) Demand Rate: See plans.
3) Steam Pipe Size: See plans.

d. Condensate Pipe Size: See plans.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heat exchangers and domestic-water heaters specified to ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heat exchangers and domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heat exchangers and domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF DOMESTIC-WATER HEATERS

A. Domestic-Water Heaters Mounting: Install domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
   1. Install shutoff valves on domestic cold-water supply piping to domestic-water heat exchangers and domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.13 "Butterfly Valves for Plumbing Piping."
   2. Install shutoff valves on steam and condensate piping to domestic-water heat exchangers and domestic-water heaters. Comply with requirements for shutoff valves specified in Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

C. Install temperature- and pressure-relief valves in top portion of domestic-water tank shells. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature- and pressure-relief valves in water piping for domestic-water heaters without storage. Extend relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install domestic-water heaters drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in domestic-water piping for heat exchangers and heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Install thermometer on each domestic-water heater inlet and outlet piping, and install thermometer on each heat exchanger and heater heating-fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 220519 "Meters and Gauges for Plumbing Piping."

G. Install pressure gauges on domestic-water heater heating-fluid piping. Comply with requirements for pressure gauges specified in Section 220519 "Meters and Gauges for Plumbing Piping."

H. Fill domestic-water heaters with water.

I. Charge domestic-water compression tanks with air.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for heating hot-water piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

C. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to domestic-water heat exchangers and heaters, allow space for service and maintenance. Arrange piping for easy removal of heat exchangers and heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Client Agency 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. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Domestic-water heat exchangers and domestic-water heaters will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Client Agency's maintenance personnel to adjust, operate, and maintain domestic-water instantaneous, semi-instantaneous domestic-water heaters.

END OF SECTION 223500

SECTION 260000

BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 STIPULATIONS

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

1.2 GENERAL CONDITIONS

A. No consideration or allowance will be granted for any alleged misunderstanding of the Contract Documents and the work to be performed.

B. The applicable Conditions of the Contract shall be held binding to the Division 26 Contractor and all subcontractors performing work under Division 26.

C. If the contractor should note any items in the drawings or specifications, the construction of which would be a code violation, he shall promptly notify the Using Agency’s representative in writing. Where the requirements of other sections of these specifications are more stringent than any applicable codes, etc., the specifications shall govern.

D. This contractor shall provide a field engineer to coordinate the work with the Using Agency’s, consultants, and other contractors on the project. The field engineer shall be on the project site and attend all construction meetings.

1.3 DEFINITIONS

A. The term "Electrical Contractor" shall mean the Contractor responsible for all work required by the Electrical specifications and drawings.

B. The term "provide" shall be interpreted to mean "furnish and install".

C. The term "work" of the Contractor or any sub-contractor includes labor or material or both.

D. In all cases where a device or part of an equipment is herein referred to in the singular, such reference shall apply to as many such items as are required to complete the installation. Quantity determinations of all materials and equipment shall be the complete responsibility of the Contractor.

E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

F. The following are definitions of terms and expressions used throughout division 26 specifications:
1. Institution- Danville State Hospital
2. Professional - Martin Rogers Associates, P.C.
3. E - Professional
4. Provide - Furnish and install.
5. Work - Labor and material.
6. Directed - Directed by the E.
7. Indicated - Indicated by the contract documents
8. Concealed - Hidden from sight; includes items in shafts, pipe and duct spaces, and above ceilings.
9. Exposed - Not concealed; work within equipment rooms and exposed to view by the occupant shall be considered exposed.

1.4 SCOPE OF WORK

A. The scope of the work shall consist of the furnishing and installing of a complete electrical system, interior and exterior, including miscellaneous systems.

B. The contractor shall provide all supervision, labor, material, equipment, machinery, and any and all other items necessary to complete the electrical systems indicated on the drawings and specified herein.

C. Items of equipment are specified in the singular; however, the contractor shall provide and install the number of items of equipment as indicated on the drawings and as required for a complete system.

D. Drawings and specifications are to be considered as supplemental to each other. Work specified, but not shown, or shown but not specified, shall be performed or furnished as

though mentioned in both specifications and drawings. Any conflict between the two should be brought to the professional's attention.

E. It is the intention of the specifications and drawings to call for finished work, tested, and ready for operation.

G. The electrical work includes, but is not limited to the following:
1. Trenching, backfilling for underground conduits.
2. Electrical disconnecting of existing fan coil units, including all related circuitry.
3. Remove all existing light fixtures and replace with new LED type.
4. Removal and reinstallation of all smoke detectors, speakers and CCTV to facilitate ceiling removal.
5. Provide new 277/480V power distribution to facilitate new gas fired packaged roof top units.
6. Provide required duct detectors for new packaged roof top units.
7. Demolish existing 277/480V power distribution system.
8. Hangers, anchors, inserts, supports, sleeves, chases.
9. Rigging, scaffolding and handling of materials and equipment.
10. Electrical Acceptance Testing and Adjusting.
11. Temporary light and power.
12. As-built documentation, training, and equipment manuals.
13. Firestopping and sealing of all penetrations.

1.5 WORK EXCLUDED

A. All work shown or specified shall be included in the Contract unless specifically mentioned herein. The following work is not included in this Contract:
1. Temperature control wiring.
2. Restoration of underground duct banks.
3. Paving

1.6 DRAWINGS

A. The drawings which constitute a part of this contract indicate the general arrangement

of panels, fixtures, devices, accessories, equipment, and other work. It is the intent of these drawings and specifications to describe a complete and integrated system. It shall be understood that while the drawings may not show every conduit, junction box and detail, all equipment and accessories which are reasonably inferable from the drawings and specifications as being necessary for the completion and proper performance of the work shall be included even though not specifically mentioned. What is called for on either the drawings or in the specifications shall be as binding as if called for on both.

B. It shall be understood that while the drawings shall be followed as closely as circumstances will permit, the Contractor is held responsible for the proper installation of materials and equipment to the true intent and meaning of plans and specifications. Should it be found that any equipment, fixtures or devices cannot be installed as shown on the drawings, the Contractor shall consult with the Professional before making any changes.

1.7 CODES, STANDARDS, FEES, PERMITS AND INSPECTIONS

A. Materials and workmanship shall comply with the contract documents and applicable codes and standards. In case of difference between applicable codes and standards and the contract documents, the contractor shall promptly notify the professional and the Using Agency in writing of such difference. Should the contractor perform any work that does not comply with the requirements of applicable codes and standards, he shall bear all costs arising in correcting those items. Applicable codes and standards shall include all ordinances, utility company regulations, and applicable requirements of nationally accepted codes and standards.

B. Except as modified by this specification, conform to the applicable provisions and recommendations of the following standards:
1. IBC – International Building Code.
2. NFPA - National Fire Protection Association, including Division 70 National Electrical Code.
3. OSHA - Occupational Safety and Health Act of 1970.
4. U.L. - Underwriters Laboratories.
5. NEMA - National Electrical Manufacturers Association.

C. Required permits and inspection certificates shall be obtained and paid for by this contractor and made available at the completion of the work. All work shall be inspected and approved by an independent licensed inspection agency.

1.8 QUALITY ASSURANCE

A. For the actual fabrication, installation, and testing of the work of this Section, use only thoroughly trained and experienced workmen completely familiar with the items required and with the manufacturers' recommended methods of installation. In acceptance or rejection of the installed work, no allowance will be made for lack of skill on the part of workmen.

B. Equipment and material required for installation under the specifications shall be new and without blemish or defect. Equipment and materials shall be products which will meet with the acceptance of authorities having jurisdiction over the work

1.9 ELECTRICAL ACCEPTANCE AND TESTING

A. Testing shall be performed on electrical equipment and systems to assure that equipment and systems are operational and within applicable standards and manufacturer's tolerances. Testing should verify that equipment and systems are installed in accordance with design specifications.

B. Qualified technicians who are trained and regularly employed for testing services shall do all testing.

C. The testing organization will conform to the general guidelines in their entirety as per section 5 of NETA Acceptance Testing Specifications 1999.

This includes the following:
1. Safety and Precautions
2. Suitability of Test Equipment
3. Test Instrument Calibration
4. Test Report

D. Four copies of the completed report will be furnished to the Institution.

E. The Institution will be notified in advance of testing. A representative of the Institution shall witness testing.

F. Inspection and testing of all applicable electrical equipment listed below shall be done in accordance with NETA ATS 1999. This will include all tests marked optional unless waived in writing by the Institution.
1. Low Voltage Circuit Breakers
   a. Insulated Case/Molded Case (100 AMP FRAME OR LARGER)
2. Grounding Systems

3. Motors
4. Motor Starters
5. Surge Arresters:
    a. Low Voltage Surge Protection Devices

G. System Function Tests
1. Perform system function tests upon completion of equipment tests as defined in 16D.1G. It is the purpose of the system function tests to prove the correct interaction of all sensing, process, and action devices.
2. Verify the correct operation of all safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of all sensing devices, alarms, and indicating devices

1.10 SUBMITTALS

A. Record Drawings: During progress of the work, maintain an accurate record of the installation of all items, location of equipment, circuits and wire sites. Upon completion of installation, transfer all record data to a blueline print of the original construction drawings and turn over to the Institution.

B. Shop Drawings;
1. The contractor shall review, approve, and shall submit with such promptness as to cause no delay in his work or in that of others, all shop drawings, and product data required for the work. No submission will be accepted without the signed approval of the contractor. The contractor shall check and verify all field measurements.
2. Distribution and handling of shop drawings shall be resolved at the time the contract is signed. All equipment and shop drawings shall be submitted for review by both the Using Agency and the professional.

3. Shop drawings shall show types, sizes, accessories, elevations, floor plans, sectional views, installation details, elementary diagrams, and wiring diagrams. Wiring diagrams shall identify circuit terminals and shall indicate the internal wiring for each item of equipment and the interconnection between the items. Drawings shall also indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. If any equipment is disapproved, the drawings shall be revised to show acceptable equipment and be resubmitted. All submittals shall include a listing and labeling statement that all material, devices,

appliances and equipment shall be labeled and listed by a certified testing laboratory or agency.

C. Shop drawings shall be submitted for the following items in electronic format:
1. Switchgear, Switchboards, panelboards and distribution transformers.
2. Disconnect switches
3. Transformers
4. Wires and Cables.
5. Receptacles, switches, and cover plates.
6. Electrical system protective device analysis.
7. Light fixtures
8. Fire Alarm

D. Manuals; upon completion of work provide maintenance manuals for the following systems:
1. Dry and oil filled type transformers
2. Panelboards
3. Fire Alarm system equipment
4. Metering and TVSS
5. Circuit breakers

1.11 SUBSTITUTION OF EQUIPMENT

A. Refer to Division 0 and Division 1 specifications regarding Substitution requirements and process.

1.12 WIRING METHODS

A. Generally all feeder and branch circuit wires shall be run in continuously grounded electrical metallic tubing (EMT), intermediate metallic conduit (IMC), or galvanized rigid steel (GRS), unless otherwise noted on drawings or specified hereinafter. The plans indicate the general location of outlet boxes and circuiting. The conduit runs for these circuits may be modified at time of installation to adapt to building construction, but in no case shall a circuit be doubled up or modified. Raceways shall be installed

concealed in the construction, except in mechanical or electrical spaces, open construction areas or where shown on the drawings.

B. Type MC cables shall be used where specified. Type MC cable shall not be used in wet or damp areas or where exposed and subject to physical damage. Cable shall be healthcare grade (HFC-90) where indicated or as required by code. MC cable usage is limited to lengths of up to 6 feet as needed for final connections to lights and within fishable partitions and masonry walls.

1.13 RACEWAY SYSTEMS

A. Legally required emergency systems and fire alarm system shall be installed in raceways separate from other power and control raceways.

B. Communications systems shall be installed in separate raceways unless otherwise noted.

C. Telephone, communications and data processing systems shall be located as remote as possible from power and control raceways but no closer than 12" if installed in steel conduit and 30" if installed in aluminum conduit or open tray.

D. Underground raceway shall be PVC Schedule 40 encased in concrete under paved areas and direct buried in grass or landscaped areas. Provide plastic spacers to maintain clearances of all grouped underground raceways with 7-1/2 inch minimum on centers.

E. Where a conduit enters building through the concrete foundation wall or floor below ground water level, a watertight entrance seal shall be used. When conduit is entering building provide transition from PVC to rigid galvanized 1’-0” from building foundation wall and provide rigid galvanized conduit through foundation to point 6” above the floor line.

1.14 SLEEVES AND PENETRATIONS

A. Contractor shall provide sleeves wherever conduits penetrate fire rated walls or floors.

B. Sleeves shall be 1/2" diameter larger than O.D. of conduits passing through.

C. All openings created by sleeves passing through walls, floors, ceilings, and partitions with fire protective ratings, shall be fireproofed to maintain the original rating of the structure.

D. Pipe sleeve in membrane waterproof construction shall extend two inches above finished floor. Installation shall be verified by the other prime contractors.

E. Sleeves through roof shall have a counter flashing fitting. Conduits smaller than 1-1/2 inches shall have pitch pockets at roof.

1.15 METAL TROUGHS AND WIREWAYS

A. Troughs and wireways shall be of code gauge steel, have removable screw on covers on front preferably, sizes as specified or as indicated on drawings. Covers shall be provided in sections where required for ease of handling.

B. Troughs and wireways shall be supported and fastened to building walls or structure. Troughs and wireways shall not be supported from equipment they serve. Equipment connected to or on troughs or wireways shall be independently supported.

1.16 PHASING

A. After all terminations at any equipment, panels, enclosures, etc., are finished, they shall be proven by producing a 1.2.3. rotation on a phase sequence meter when connected, “A”, “B”, “C”.

B. If any provisions of this section regarding system and phase color coding, identification and positioning and sequence are violated, the electrical contractor shall rewire the circuit and/or the terminations in order to produce the desired construction and electrical systems characteristics as herein specified and shown, at no expense to the department and at the department’s convenience. Permission to deviate must be approved in writing by the architect prior to installation.

1.17 OUTLET BOXES

A. All outlet boxes for concealed work shall be code gauge hot dipped galvanized stamped steel. All wall boxes on exposed work shall be aluminum or cadmium plated cast iron or cast ferrous alloy with threaded openings.

B. Outlet boxes shall be firmly anchored in place and where required provided with fixture supports. Provide special supports for recessed fixtures, etc. Suitable expansion screws shall be used for securing boxes to solid masonry and approved type toggles for securing to hollow masonry units. Boxes in hung plaster ceilings shall be provided with two hanger bars and two hanger clips for each bar.

C. Not more than four conduits for branch circuits shall enter a standard outlet box. Where the number of conduits entering an outlet box exceeds four, box size shall be increased.

1.18 JUNCTION, SPLICE AND PULL BOXES

A. Junction boxes, pull boxes and cable support boxes of proper size and design shall be furnished and installed to facilitate pulling of wires and as required by the N.E.C. In addition any run of conduit shall have a minimum of one pull box every 100 feet. No conduit run shall be installed with more than four 90 degree bends or equivalent without a pull box.

B. Junction boxes shall be used where it is necessary to combine motor leads and control wires in one box. Control wires shall not pass through motor and/or starter disconnect switches.

C. Unless otherwise detailed on drawings, pull boxes shall be constructed of #12 gauge steel (0.1046 inches) and shall have steel covers secured by machine screws. Where cables pass through same they shall be provided with porcelain cable clamps.

D. Covers shall be accessible and designed for quick removal.

E. Where pulling in of wire is not included under this section of specifications, provide pull boxes in horizontal conduit runs every 100 feet and as indicated.

F. When the system is finished, the boxes shall contain no openings, except that into which the conduit passes. Junction boxes and pull boxes shall not be exposed in finished spaces and where necessary to do so, shall meet the approval of the architect. Pull boxes or junction boxes occurring in finished areas shall have the removable cover plates flush with finished ceiling or wall. Suitable insulated supports shall be provided in all pull boxes so that the conductors will not remain unsupported for a distance greater than three feet.

G. Support junction, splice and pull boxes independently to building structure with no weight bearing on conduit.

H. Watertight or in wet locations, box shall be cast iron with threaded hubs, galvanized with rust resistant parts and airtight-watertight gaskets between box and cover. Sheet stainless steel or aluminum thickness shall be acceptable alternates where mounted exposed.

1.19 COLOR CODING

A. All wires shall be color coded throughout the entire installation using the same color coding for each phase at each panelboard, motor, transformer, fixture, receptacle and other utilization devices.

B. The color coding shall match the existing building identification scheme. If no scheme exists, the color coding shall be as follows:

For 208/120 volt system		For 277/480 volt system	
Phase A -	Black	Phase A -	Brown
Phase B -	Red	Phase B -	Orange
Phase C -	Blue	Phase C -	Yellow
Neutral -	White	Neutral -	White with a colored stripe or gray.
Ground -	Green	Ground -	Green

C. Where feeder wiring is not factory color-coded, the feeder wiring shall be identified at terminations and pull boxes as indicated above with strongly adherent paint, or dye or polyvinyl tape for a distance of 6 inches minimum from the point of termination.

D. Control cable (copper): Multi-conductor and single cables used for control and signaling shall consist of the number of #14 AWG minimum 7 strand color coded conductors required. Conductors shall have cross-linked polyethylene insulation (XLPE) or TFE insulation rated for 600 volts.

1.20 PROTECTION OF WORK

A. All work shall be protected at all times. Pipe openings shall be closed with caps or plugs during installation. Equipment shall be tightly covered against dirt, water, chemicals, and mechanical injury during the entire progress of the installation. The electrical contractor shall make good all damage caused either directly or indirectly by failure to protect his work as required.

1.21 SCAFFOLDING

A. Providing all scaffolding necessary for installation of electrical work. Upon completion of installation, scaffolding shall be dismantled and removed.

1.22 TEMPORARY LIGHT AND POWER

A. The electrical contractor shall provide, maintain and operate a complete and suitable 120/208 volt temporary electrical distribution system for light and power. All necessary materials, i.e., lighting, panelboards, transformers, cables, circuit breakers, etc., including GFI outlets shall be provided, as well as maintenance of and removal of the system. Temporary power shall be derived from the existing electrical distribution system.

B. Minimum temporary lighting within all portions of the building, including garage, shall be based upon a lighting intensity of five (5) foot candles throughout the following minimum lamping requirements shall be provided by electrical contractor.
   1. Rooms or spaces under 100 S.F. at least one (1) 100- Watt lamp.
   2. Rooms or spaces 100 S.F. to 250 S.F., not less than two (2) 100-Watt lamps.
   3. Rooms or spaces over 250 S.F. and under 500 S.F., not less than four (4) 100-Watt lamps.
   4. Rooms or spaces over 500 S.F., not less than two (2) 200-Watt lamps every 1,000 S.F., or fraction thereof.
   5. All wiring, outlets, and lamps as required shall be provided to create proper adequate lighting in stairs, corridors, and passages. For security reasons lighting in stairs, corridors and passages shall remain energized constantly, 24 hours of each day.

1.23 APPROVAL OF THE WORK

A. All workmanship, equipment and materials supplied under this contract shall be acceptable to the Institution and his representatives who shall have the power to reject any items which in their judgment are not in full accordance with the drawings and specifications.

1.24 PERFORMANCE OF EQUIPMENT

A. All materials, equipment and appurtenances of any kind, shown on the drawings, hereinafter specified or required for the completion of the work in accordance with the intent of these specifications, shall be completely satisfactory and acceptable in operation, performance and capacity.

B. No approval either written or verbal of any drawings, descriptive data or samples of such material, equipment and/or appurtenances shall relieve the Electrical Contractor of his responsibility to turn over the same to the in perfect working order at the completion

of the work.

C. 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 damaged prior to acceptance by the will be held to be defective material and shall be removed and replaced with proper and acceptable materials, equipment and/or appurtenances or put in proper and acceptable working order, satisfactory to the Professional and the Using Agency without additional cost.

1.25 GUARANTEES

A. All work furnished under the contract shall be guaranteed against any and all defects in workmanship and/or materials for a period of not less than one (1) year, or as otherwise specified, from the date of final acceptance of the installation. Any defects of workmanship developing during this period shall be remedied and any defective material replaced without additional cost. When defects in the Division 26 contractor's work cause damage to the work of other contractors, all such damage shall be repaired by the Division 26 contractor and all work restored to its original condition at the expense of the Division 26 contractor.

1.26 SURFACE CONDITIONS

A. Examine areas and conditions under which equipment and components are to be installed, and notify engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until satisfactory conditions have been corrected in a manner acceptable to Professional.

B. Verify that the work of the Section may be performed in strict accordance with all pertinent codes and regulations, the original design, and the manufacturers' recommended installation methods.

1.27 COORDINATION

A. Coordinate the installation of electrical items with the schedules for work of the other trades to prevent unnecessary delays in the total work.

B. Electrical work shall be coordinated with other trades involved in the construction project.

1.28 INSTALLATION PROVISIONS

A. Install all equipment and conduit so as to preserve access to all fittings and accessories. In general, conduits shall be concealed unless otherwise indicated on the plans, but when exposed they shall be run so as to allow maximum head room consistent with proper ceiling clearances.

B. All conduit shall be run parallel with the lines of the building, as close to walls, columns, and ceilings as may be practical and consistent with proper grade and the maintenance of proper clearances for access to all parts requiring servicing. All conduit shall be kept at least one inch from the finished insulated surfaces of piping or ductwork and all adjacent work. No conduit shall cross below the head of any window or door.

C. The contractor shall be responsible for full coordination of elements of the heating, ventilating and air conditioning, plumbing, fire protection, and electrical systems with shop drawings of the floor construction so that the proper openings and sleeves or supports, etc., are provided for conduit or other equipment passing through floor slabs and roof systems.

1.29 BEAM PENETRATION

A. If required to maintain ceiling heights, clearances and interferences, beam penetrations may be required. The electrical contractor shall submit details of the required penetration to the professional for approval prior to installation.

1.30 EARTHWORK

A. This contractor shall provide all excavating, backfilling, shoring, sheeting, pumping, bailing etc., required for the work of this Division.

B. Trench depths shall allow adequate cover over conduits. Walls shall be vertical and bottoms shall be instrument graded.

C. Excavation under footings of foundations and deeper than the angle of repose from footings and foundations shall be backfilled with 3,000 psi concrete.

D. The method of sheeting and shoring shall be the responsibility of the contractor. The sheeting and shoring shall comply with the requirements of the U.S. Department of Labor and any other applicable law or code. Drawings for proposed sheeting and shoring shall be designed by a registered structural engineer and paid for by the contractor. The plans and details for the sheeting and shoring shall be submitted for a general review by the engineer.

E. Placement and compaction of fill: Refer to specification section 312010 for requirements.

1.31 SUPPORTS, ANCHORS AND FASTENERS

A. Furnish to the proper contractor all inserts, anchors or other required items which are to be built in by them for securing all hangers or other supports for conduit and for anchorage of electrical apparatus and equipment. Supervise and coordinate the placing of these anchors, inserts, etc., with other contractors.

1.32 TESTING

A. General:
1. Upon completion of this portion of the work, test all parts of the electrical system in the presence of the engineer.
2. Demonstrate that all equipment furnished, installed, and/or connected under this Section of these specifications functions electrically in the required manner.
3. Contractor shall maintain the balance of electrical power consumption on each phase of panelboard and switchboard.

B. Test requirements:
1. All systems shall test free from short circuits and grounds, shall be free from mechanical and electrical defects, and shall show an insulation resistance between phase conductors and ground of not less than that required by the National Electrical Code.
2. Test all circuits for proper neutral connections.
3. If voltage and regulation are not within acceptable limits, arrange with the service utility for proper voltage.
4. Measure minimum and maximum voltages, measure voltage between phase wires and neutral, and immediately deliver to the professional a report on all voltage measurements.

1.33 ELECTRICAL WORK FOR HVAC SYSTEMS

A. .2 Contractor will furnish all necessary electrical devices required for all
equipment furnished by him, except starters, disconnects and overload protection, unless otherwise note.

B. Starters, disconnects and overload protection shall be provided under Division 26, except where these items are integral with the HVAC equipment.

C. All other electrical devices such as thermostats, relays, motorized valves, dampers, control elements, etc. will be furnished by the .2 Contractor as required to make his systems complete and operable.

D. For the purpose of this specification, power and control wiring shall be defined as follows:

Power Wiring

1. All wiring from the power source (panelboards) to the disconnect switch or disconnect switch and starter, including wiring from these switches to the equipment and final connection to the motor or terminal block on the equipment.
2. All feeder and branch circuit conductors and conduit shall be the responsibility of the .4 Contractor unless otherwise noted.
3. .4 Contractor shall verify the exact location of disconnects and combination disconnects and starters when not indicated on the drawings.

Control Wiring

1. All other wiring required, whether line voltage or low voltage, to provide for the operation of the equipment shall be considered as control wiring.
2. .2 Contractor shall do all control wiring, including all wiring necessary to interconnect instrumentation to sensing elements, indicators, etc. All wiring shall conform to the N.E.C. and the control manufacturer's requirements.

E. .2 Contractor shall furnish detailed wiring diagrams for all associated electrical work to be done by the .4 Contractor as hereinafter specified.

F. Any disconnect switches, fused or unfused, required in addition to the safety disconnect switch furnished by the .4 Contractor, shall be furnished by the .2 Contractor.

1.34 ELECTRICAL WORK FOR FIRE SUPPRESSION SYSTEMS

A. .5 Contractor shall provide sprinkler flow and tamper switches. .4 contractor shall wire sprinkler flow and tamper switches.

1.35 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for electrical installations. Perform cutting by skilled mechanics of the trades involved.

B. Repair disturbed surfaces to match adjacent undisturbed surfaces.

1.36 TOUCHUP PAINTING

A. Thoroughly clean damaged areas and provide primer, intermediate, and finish coats to suit the degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

1.36 FIRESTOPPING

A. Provide firestopping for all electrical penetrations through floor slabs, fire-rated walls and partitions, and at each floor level in vertical service shafts used for mechanical services, as specified herein and approved by the Professional.

B. Provide firestopping for the following applications:
1. Penetrations through fire-rated floor slabs, both empty holes and holes accommodating items such as cables, pipes, ducts, conduit, etc.
2. Penetrations through fire-rated walls, ceilings and partitions.

C. Sealant: Provide ready-to-use silicone penetration seal that will stop passage of fire, smoke, and water through fire-rated wall and floor penetrations and will cure in the presence of atmospheric moisture to produce durable and flexible seal, and will form airtight and watertight bonds with most common building materials in any combination including cement, masonry, steel, and aluminum.

D. UL Classification: Provide firestopping materials that are currently classified with UL as "Fill, Void, or Cavity Materials", and "Through Penetration Firestop Systems".

E. Fire Tests: Provide firestopping materials that have been tested in accordance with ASTM E-814 "Methods for Fire Tests of Through-Penetration Fire Stops" and UL 1479 "Fire Tests of Through-Penetration Firestops".

F. Submittals: Submit manufacturer's technical product data, including product description, technical data, and installation instructions.

G. Where sleeves are employed, the average clearance between sleeve and piping shall not exceed one inch (1").

H. Metal Pipe and Conduits:
1. Support sealant with three inch (3") thickness of mineral wool, inserted and compressed into opening.
2. Apply sealant bead to depth of one-half inch (1/2") by pushing bead in front of

nozzle to fill void above mineral wool support.

3. Tool sealant immediately after application and before skin forms. Protect seal from any disturbance for 48 hours minimum.

I. Where unusual openings are required because of size, shape of wall or floor construction, the fire stop application and material used shall be referred to the Professional for review and approval.

J. Fire stopping materials shall be:
   1. Fire stop caulk - 3M CP25WB+, or CP25 N/S, or Dow Corning #2000.
   2. Intumescent pipe wrap - 3M FS195+ wrap/strip.

END OF SECTION 260000

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Sleeves for raceways and cables.
   2. Sleeve seals.
   3. Grout.
   4. Common electrical installation requirements.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      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 cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Plastic. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

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.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and HVAC sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing HVAC sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing HVAC sleeve seals.

3.3 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 HVAC 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.

3.4 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 07 Section "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XLPE or TFE.

C. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type AC / MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

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.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in non flexible conduit raceway.

B. Feeders: Type THHN-THWN, single conductors in non flexible conduit raceway.

C. Exposed Branch Circuits: Type THHN-THWN, single conductors in non flexible raceway

D. Non Emergency Branch Circuits Concealed in stud framing Walls and Partitions: Armor-clad cable, Type AC HCF-90 for healthcare facilities.

E. Non Emergency Branch Circuits Concealed in Ceilings: single conductors in non flexible conduit raceway.

F. Emergency and Non Emergency Branch Circuits Concealed in Ceilings making final connections to light fixtures and equipment: Armor-clad cable, Type AC HCF-90 for healthcare facilities ONLY where allowed by Article 517 of NFPA 70.

G. Emergency and Non Emergency Branch Circuits Concealed in Insulated Concrete Forms (ICF): single conductors in non flexible conduit raceway.

H. Emergency Branch Circuits Concealed in Ceilings, stud framing Walls and Partitions: non flexible conduit raceway.

J. Branch Circuits Concealed in Concrete Walls, Concrete Masonry Unit Walls, and Underground: Type THHN-THWN, single conductors in non flexible raceway.

K. Class 1 Control Circuits: Type XLPE or TFE, in raceway.

L. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Sections "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. 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.

H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

J. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. 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. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 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. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-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. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by10 feet in diameter.

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. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.

C. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except as otherwise indicated.

3. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. 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. Metal-clad cable runs.

B. 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.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 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. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. 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 so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. 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, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, 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.

E. 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.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.
   a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
   b. Perform tests by fall-of-potential method according to IEEE 81.

B. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes:
   1. Hangers and supports for electrical equipment and systems.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.

   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. HVAC-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Cooper B-Line, Inc.; a division of Cooper Industries.
         2) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
   3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   6. Toggle Bolts: All-steel springhead type.
   7. Hanger Rods: Threaded steel.

F. Non-Penetrating Roof Conduit Supports: Frame system constructed of strut and bases used to support conduit on flat roofs.
   1. Design to allow a sturdy support without penetrating or causing damage to the roof membrane. Designed to be compatible with all current types of decking and with all commonly used built-up and single-ply roofing membranes where roof-mounted conduits occur. Provide support pads to further protect the roof membrane. Contractor shall maintain any current warranty or bond on the roofing and whether under warranty or not, must be done in accordance with the manufacturer's written directions.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Miro 8-DS
         2) Durablok DB620
         3) Arlington RTS421

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 single-bolt conduit clamps using spring friction action for retention in support channel.

D. 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, as permitted in 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 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 reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases 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 Division 03 Section "Cast-in-Place Concrete".

C. Anchor equipment to concrete base.
   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: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. EMT: ANSI C80.3.

C. FMC: Zinc-coated steel.

D. LFMC: Flexible steel conduit with PVC jacket.

E. Fittings for Conduit (Including all Types and Flexible and Liquid tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Fittings for EMT: Steel compression type.

2.2 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

B. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include 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.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, cadmium plated cast iron or cast ferrous alloy, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.

G. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, 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: IMC. Includes raceways in the following locations:
a. HVAC rooms.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Concealed in slabs or below slabs on grade. Not Allowed.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Damp or Wet Locations: Rigid steel conduit.

8. Raceways for Communications Cable: EMT.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.
10. Raceway for Fire Alarm Cable: Red factory painted EMT.

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.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. 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.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

I. 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.

J. Raceways for Optical Fiber and Communications Cable: Install as follows:
1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

K. Install raceway sealing fittings at suitable, approved, and accessible locations 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 where required by NFPA 70.

L. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
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 the Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.
2. 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.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

M. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations.

N. 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.

3.3 INSTALLATION OF EXTERIOR UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit.
2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
4. Install 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. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 260533

SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 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.

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. 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. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
   2. Sealing Elements: EPDM rubber 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.
   4. 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.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. HOLDRITE.

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] <Insert dimension> annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed[or unless seismic criteria require different clearance].
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 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 260544

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Condition 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. Identification for conductors.
2. Underground-line warning tape.
3. Warning labels and signs.
4. Instruction signs.
5. Equipment identification labels.
6. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

A. Comply with ANSI 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. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

PART 2 - PRODUCTS

2.1 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 FLOOR MARKING TAPE

A. 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:
1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils.

3. Foil Core Thickness: 0.35 mil.
4. Weight: 28 lb/1000 sq. ft.
5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign 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."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Select 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 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

F. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    b. Colors for 208/120-V Circuits:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
    c. Colors for 480/277-V circuits:
        1) Phase A: Brown
        2) Phase B: Orange
        3) Phase C: Yellow

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

B. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

C. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

D. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

E. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

F. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
a. Controls with external control power connections.

H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. 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.
   b. Outdoor Equipment: Engraved, laminated acrylic or melamine label
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 260553

SECTION 260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies, and the setting of these devices. The limit of this study is for new equipment only and utilize infinite primary source.
   1. Coordination of series-rated devices is permitted only where indicated on Drawings.
   2. The "Fault Current and Coordination Study" shall be provided by the manufacturer of the main distribution equipment

1.4 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals:
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Coordination-study report.

3. Equipment evaluation report.
4. Setting report.

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 organization experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Testing Agency Qualifications: Member company of the InterNational Electrical Testing Association.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise testing specified in Part 3.

D. Comply with IEEE 399 for general study procedures.
1. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide computer software programs developed by one of the following:
1. CYME International, Inc.
2. EDSA Micro Corporation.
3. Electrical Systems Analysis, Inc.
4. SKM Systems Analysis, Inc.
5. 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, Table 7-4.

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.
   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. Where required, coordinate main devices with Utility Company devices.

B. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices not submitted for approval with coordination study may not be used in study.

3.2 FAULT-CURRENT STUDY

A. Source Impedance: Obtain from new transformer shop drawing. Utilize infinite primary source.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project and use approved computer software program to calculate values. 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 the following:
   1. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.50.
   2. Low-Voltage Fuses: IEEE C37.46.
   3. Circuit Breakers: IEEE C37.13.

E. Study Report: Enter calculated X/R ratios and interrupting (5-cycle) fault currents on electrical distribution system diagram of the report. List other output values from computer analysis, including momentary (1/2-cycle), interrupting (5-cycle), and 30-cycle fault-current values for 3-phase, 2-phase, and phase-to-ground faults.

F. Equipment Evaluation Report: Prepare a report on the adequacy of overcurrent protective devices and conductors by comparing fault-current ratings of these devices with calculated fault-current momentary and interrupting duties.

3.3 COORDINATION STUDY

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. The .4 contractor shall be responsible to obtain documentation of existing system from utility (POC) point of connection via existing 12.47-2.4kV to new transformer vial on-site survey.
   2. Impedance of utility service entrance.
   3. Electrical distribution system diagram showing the following:
      a. Load current that is the basis for sizing continuous ratings of circuits for cables and equipment.
      b. Circuit-breaker and fuse-current ratings and types.
      c. Relays and associated power and current transformer ratings and ratios.
      d. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      e. Generator kilovolt amperes, size, voltage, and source impedance.
      f. Cables. Indicate conduit material, sizes of conductors, conductor insulation, and length.
      g. Busway ampacity and impedance.
      h. 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:
      a. Special load considerations, including starting inrush currents and frequent starting and stopping.
      b. Magnetic inrush current overload capabilities of transformers.
      c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Ratings, types, and settings of utility company's overcurrent protective devices.
e. Special overcurrent protective device settings or types stipulated by utility company.
f. Time-current-characteristic curves of devices indicated to be coordinated.
g. 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.
h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
i. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

B. Perform coordination study and prepare a written report using the results of fault-current study and approved computer software program. Comply with IEEE 399.

C. Comply with NFPA 70 for overcurrent protection of circuit elements and devices.

D. Comply with IEEE 242 recommendations for fault currents and time intervals.

E. Transformer Primary Overcurrent Protective Devices:
1. Device shall not operate in response to the following:
a. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
b. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device shall protect transformer according to IEEE C57.12.00, for fault currents.

F. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

G. 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. Verify adequacy of phase conductors at maximum three-phase bolted fault currents, equipment grounding conductors, and grounding electrode conductors at maximum ground-fault currents.

H. 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. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. 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 series devices, including power utility company's upstream devices. Show the following specific 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.

3. Completed data sheets for setting of overcurrent protective devices.

3.4 OVERCURRENT PROTECTIVE DEVICE SETTING

A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.

B. Testing: Perform the following device setting and prepare reports:
1. After installing overcurrent protective devices and during energizing process of electrical distribution system, perform the following:
a. Verify that overcurrent protective devices meet parameters used in studies.
b. Adjust devices to values listed in study results.
2. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.

END OF SECTION 260573

SECTION 260583

ARC FLASH HAZARD STUDY

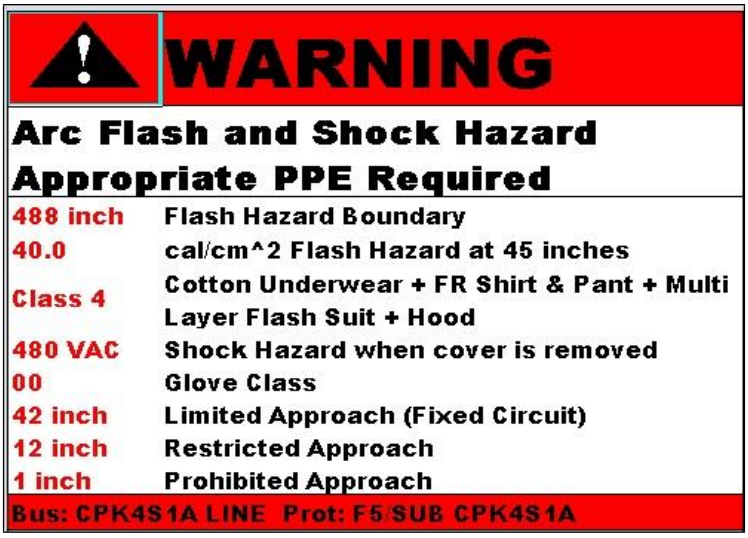
PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 DESCRIPTION

A. Provide an Arc Flash Hazard Study for the electrical distribution system shown on the one line drawings. The limit of this study is at the first piece of existing remaining equipment LIS1. The intent of the Arc Flash Hazard Study is to determine hazards that exist at each major piece of electrical equipment shown on the one line drawing. This includes meter center and panelboards. The study will include creation of Arc Flash Hazard Warning Labels. These labels serve as a guide to assist technicians and others in the selection of proper Personal Protective Equipment when working around exposed and energized conductors. The electrical contractor will install the labels.



Example of Arc Flash Warning Label

B. The arc flash hazard study shall include the electrical distribution system equipment shown on the one line drawing. If an existing up-to-date current short-circuit and protective device coordination study is not available, perform a short circuit and protective device coordination study for the electrical distribution system before performing the Arc Flash Hazard Study. The arc flash hazard study shall consider operation during normal conditions alternate operations, emergency power conditions, and any other operations, which could result in maximum arc flash hazard.

1.3 QUALIFICATIONS

A. The Contractor shall have the study prepared by qualified engineers of an independent consultant. The consultant shall be a Registered Professional Electrical Engineer (licensed in the state where the project is completed) who has at least ten (10) years of experience and specializes in performing power system studies.

B. The arc flash hazard study shall be performed using SKM PowerTools for Windows computer software packages or equal.

C. Pre-approved: Power Systems Engineering, P.S. - Covington, WA.

D. Approved equal.

1.4 SUBMITTALS

A. The contractor shall submit the arc flash hazard study and arc flash warning labels at least 30 days prior to energizing the electrical equipment.

B. Submit three (3) copies of the power systems study and (1) set of warning labels.

PART 2 - PRODUCTS

2.1 SHORT CIRCUIT STUDY

A. Provide a short circuit study as specified in Section 260573.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

A. Provide a current up-to-date protective device coordination study. If one does not exist, then perform a protective device coordination study as specified Section 260573.

2.3 ARC FLASH HAZARD STUDY

A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed.

B. The study shall be calculated by means of the SKM PowerTools for Windows computer software package. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.

C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub part S and IEEE 1584 Standards.

D. Determine the following
   1. Flash Hazard Protection Boundary
   2. Limited Approach Boundary
   3. Restricted Boundary
   4. Prohibited Boundary
   5. Incident Energy Level
   6. Required Personal Protective Equipment Class
   7. Type of Fire Rated Clothing

E. Produce an Arc Flash Warning label listing items 1 – 7 above. Also include the bus name and voltage. Labels shall be printed in color and be printed on adhesive backed Avery Labels. See example above.

F. Produce Bus Detail sheets that lists the items D 1 – 7 from above and the following additional items:
   1. Bus Name
   2. Upstream Protective Device Name, Type, and Settings
   3. Bus Line to Line Voltage

G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:
   1. Bus Name
   2. Upstream Protective Device Name, Type, and Settings
   3. Bus Line to Line Voltage
   4. Bus Bolted Fault
   5. Protective Device Bolted Fault Current
   6. Arcing Fault Current
   7. Protective Device Trip / Delay Time
   8. Breaker Opening Time
   9. Solidly Grounded Column
   10. Equipment Type

11. Gap
12. Arc Flash Boundary
13. Working Distance
14. Incident Energy
15. Required Protective Fire Rated Clothing Type and Class

PART 3 - EXECUTION

3.1 Analyze the short circuit, protective device coordination, and arc flash calculations and highlight any equipment that is determined to be underrated or causes an abnormally high incident energy calculation. Propose approaches to reduce the energy levels. Proposed major corrective modifications will be taken under advisement by the Professional, and the Contractor will be given further instructions.

3.2 The results of the power system study shall be summarized in a final report. The report shall include the following sections:

A. Introduction, executive summary and recommendations, assumptions, reduced copy of the one line drawing.

B. Arc Flash Evaluations Summary Spreadsheet

C. Bus Detail Sheets

D. Arc Flash Hazard Warning Labels printed in color on adhesive backed labels and apply the arc flash warning labels to the appropriate equipment.

END OF SECTION 260583

SECTION 260800

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specification sections "General Conditions", "Special Requirements" and "General Requirements" form a 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. General provisions and other electrical systems are specified in other Sections of Divisions 26 & 28.

B. Commissioning is an ongoing process and shall be performed throughout construction. Commissioning requires the participation of Division 26 to ensure that all systems are operating in a manner consistent with the Contract Documents. Division 26 shall be familiar with the commissioning plan issued by the Commissioning Agent as it applies to the work of Division 26 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

C. Commissioning shall conclude with the completion of all required deferred testing, training and system documentation as specified and required to ensure the proper operation of the electrical equipment and systems provided by this Division.

D. This Section covers electrical systems commissioning, as required to demonstrate that the equipment and systems of Division 26 is ready for safe and satisfactory operation, as defined by project documents. Commissioning shall include, but shall not be limited to, identification of piping and equipment, cleaning, lubrication, start-up, check-out, and testing, adjusting, and balancing of systems, preparation of equipment and systems documentation and of maintenance and operation manuals, The Using Agency’s operating personnel training, and preparation of record drawings.

E. This section does not alter the equipment start-up and testing requirements indicated in Division 26 sections of the building specifications. This section is to help define/supplement the requirements of Section 01 9000 where applicable.

1.3 QUALITY ASSURANCE

A. The Department shall identify an electrical commissioning supervisor. The electrical commissioning supervisor should have a minimum of ten years experience in electrical contracting. The electrical commissioning supervisor shall become familiar with the design intent and the requirements of the commissioning process as defined in this Section. The electrical commissioning supervisor shall attend all commissioning meetings and coordinate the commissioning schedule as outline by the commissioning agent. The electrical commissioning supervisor shall assist the Commissioning Agent in coordinating and executing the required commissioning activities.

1.4 ELECTRICAL PRIME CONTRACTOR RESPONSIBILITIES

A. Include and itemize the cost of commissioning in the contract price with an estimated breakdown of hours for meeting and functional testing requirements.

B. The Electrical Prime Contractor shall assemble all record drawings and all records of Code authority inspections and approvals. Electrical Prime Contractor shall review operation and maintenance information and as-built drawings and obtain all documentation from tests for review. Electrical Prime Contractor shall document warranty start and dates.

C. The electrical commissioning supervisor shall be responsible for scheduling, supervising, and coordinating the startup, testing and commissioning activities as specified herein with the CA. Specific requirements of the Electrical Prime Contractor and associated Prime Contractors are identified in this Section and in other Sections of this Division.

D. The Commissioning Agent shall conduct independent verification of installation, pre-functional, start-up and functional testing.

E. Electrical commissioning shall take place in three phases. Commissioning requirements for each phase are as follows:

1. Construction Phase

   a. Attend a Commissioning Scoping meeting and additional commissioning meetings as required throughout the commissioning process. These commissioning meetings will be monthly during early construction and increase in frequency to weekly during the start-up, prefunctional and functional testing phases. Electrical Prime Contractor shall assure that all associated Prime Contractors who have commissioning responsibilities attend the Commissioning Scoping meeting and other commissioning meetings, as appropriate, during the construction process.
   b. Report in writing to the Commissioning Agent at least as often as commissioning meetings are scheduled concerning the status of his activities as they affect the commissioning process, the status of each discrepancy identified, the prefunctional and functional testing process, explanations of any disagreements with the identified deficiencies, and proposed resolution and schedule.
   c. Provide the Commissioning Agent with normal cut sheets and shop drawing submittals of equipment that is to be commissioned.
   d. Provide documentation to the Commissioning Agent for development of pre-functional and functional performance testing procedures, prior to normal O&M manual submittals. This documentation shall include detailed manufacturer installation, start-up, operating, troubleshooting and maintenance procedures; full details of any The Using Agency-contracted tests; fan and pump curves; full factory testing reports, if any; and full warranty information, including all responsibilities of The Using Agency to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent. The Commissioning Agent may request further documentation necessary for the development of functional performance testing and the commissioning process. This data request may be made prior to normal submittals.
   e. Develop and submit to Commissioning Agent, for review prior to equipment or system startup, a complete startup and initial checkout plan using manufacturer's start-up procedures. The Commissioning Agent shall

conduct their own pre-functional testing check in parallel with the Electrical Prime Contractor.

f. Review the Commissioning Agent's pre-functional checksheets and sign-off on the appropriate areas when Electrical Prime Contractor and associated Prime Contractors are complete. The prefunctional test sheets will be developed by the Commissioning Agent. Only when each portion of the pre-functional test sheet is signed off will the respective Prime Contractor be able to move onto the next phase of the start-up and check-out.

g. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the Commissioning Agent for review.

h. Assist in clarifying the proposed operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

i. Commissioning Agent shall prepare the specific functional test procedures as specified herein. The Electrical Prime Contractor and associated Prime Contractors shall review the Commissioning Agent's proposed functional performance test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.

j. Commissioning agent shall prepare a preliminary schedule for Division 26 commissioning activities for use by the Commissioning Agent and shall update the schedule as appropriate. The Electrical Prime Contractor & all associated Prime Contractors shall update the commissioning activities and notify any delays in the progress meetings. Each Prime Contractor shall notify the Commissioning Agent during the commissioning meetings when commissioning activities not yet performed or not yet scheduled will delay construction.

k. Electrical equipment start-up shall not be initiated until the complete sign-off of the pre-functional check-sheets as developed by the commissioning agent as specified in other Sections of Divisions 26 & 28.

l. Provide startup testing for all normal and emergency power equipment and shall execute the electrical-related portions of the prefunctional checklists for all commissioned equipment during the startup and initial checkout

process. The commissioning agent shall conduct an independent start-up once the respective Prime Contractor is complete with their requirements.

m. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the Commissioning Agent.

n. Correct current Design Engineer punch list and Commissioning Agent deficiency items before functional performance testing can begin.

o. The Commissioning Agent shall generate the functional testing procedure and record to the Electrical Prime Contractor. The Electrical Prime Contractor shall review and provide support to the functional testing process or applicable systems. Electrical Prime Contractor shall open and close disconnects and switches normal and emergency power requirements as directed by the commissioning agent and the functional testing procedures.

p. Report in writing to the Commissioning Agent at least as often as commissioning meetings are being scheduled concerning the status of each outstanding discrepancy identified during commissioning, prefunctional and functional performance testing. Report shall include description of the identified discrepancy, explanations of any disagreements, and proposals and schedule for correction of the discrepancy.

2. Acceptance Phase. Electrical Prime Contractor and associated Prime Contractors shall assist and cooperate with the Commissioning Agent in the commissioning process by:

a. Putting all electrical equipment and systems into operation and continuing the operation during each working day of the test and balance and commissioning effort, as required.

b. For a given system, have all required prefunctional checklists, calibrations, startup and selected functional tests approved by the Commissioning Agent prior to beginning the test and balance process.

c. Providing skilled technicians to execute starting and operation of equipment.

d. The Commissioning Agent will conduct functional performance testing. The associated Prime Contractor may be required to have a skilled technician present during functional testing although it is suggested that one be available to make adjustments or assist in problem-solving.

e. The Commissioning Agent will require full and part load performance verifications as well as simulated testing requirements. The associated Prime Contractor shall be prepared to operate different components of various systems during the functional testing.
f. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Agent and Design Engineer.
g. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original design intention to as-built conditions.
h. Maintain on site redline as built drawings and produce final "As-built" drawings for all project drawings and Contractor-generated coordination drawings.
i. Provide specified training of The Using Agency's operating personnel in accordance with the commissioning agent's overview and outline.
j. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

3. Warranty Period. During the warranty period, the Electrical Prime Contractor and associated Prime Contractors shall:

a. Be available during seasonal or deferred functional performance testing conducted by the Commissioning Agent, according to the specifications.
b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

PART 2 - PRODUCTS

2.1 SYSTEMS TO BE COMMISSIONED

A. The following are systems to be commissioned.

1. Normal Power Systems
2. Lighting Control Systems
3. Fire Protection Systems (Witness Only)

2.2 TEST EQUIPMENT

A. All standard testing equipment required to the electrical portion startup, initial checkout shall be provided by the Prime Contractor responsible for the equipment or system being tested.

B. The Commissioning Agent shall perform their own system verification and performance check-out. The Commissioning Agent shall provide their own calibrated equipment as required for this testing.

C. All testing equipment associated with functional performance verification and point-to-point required shall be the responsibility of the commissioning agent.

D. Special equipment, tools and instruments (only available from vendor or specific to a piece of equipment) required for the functional testing of that equipment, according to the requirements of the contract documents and the functional test procedures shall be provided to the Commissioning Agent by the installing Prime Contractor and shall become the property of The Using Agency at project completion as indicated in the specification.

E. Proprietary test equipment and software required by any manufacturer for programming and / or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide test equipment, demonstrate its use and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of The Using Agency upon successful completion of the commissioning process as required in the specifications.

PART 3 - EXECUTION

3.1 SUBMITTALS

A. Electrical Prime Contractor shall provide submittal documentation relative to commissioning as required in this Section Part 1.

3.2 STARTUP PLAN AND PREFUNCTIONAL TESTING

A. The Electrical Prime Contractor and associated Prime Contractors shall be responsible for the installation of complete systems and sub-systems, fully functional, meeting the design objectives of the Contract Documents. Electrical Prime Contractor and associated Prime Contractors shall follow the approved start-up, initial checkout, and prefunctional testing procedures. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility to the commissioning agent.

B. Pre-functional test forms as written by the commissioning agent shall be required for each piece of equipment to ensure that the equipment and systems are properly installed and ready for operation, so that functional performance testing to may proceed without delays. Sampling strategies shall be used on lower level components of equipment for pre-functional testing. The pre-functional testing for all equipment and subsystems of a given system shall be successfully completed and documented prior to functional performance testing of the system. The Electrical Prime Contractor and associated Prime Contractors shall sign off on the Commissioning Agent’s pre-functional test sheets that they are complete and the system is ready. The commissioning agent will verify and conduct their own independent verification and start-up in parallel to the respective Prime Contractor’s verification. Any deficiencies identified during this process shall be noted and reviewed by the associated Prime Contractors. Start-up and functional testing shall not proceed until all the deficiencies are corrected and verified by the commissioning agent.

C. The following procedures shall apply to all equipment and systems to be commissioned.

1. Start-up and Initial Checkout Plan. The Commissioning Agent shall develop the detailed start-up and prefunctional testing plans for all equipment. The primary role of the Commissioning Agent in this process shall be to review the installation

for construction completeness and ensure that all components have been installed as per the design documents. Only when pre-functional testing is complete and signed off by all Prime Contractors, shall the equipment be started-up by the associated Prime Contractor. Equipment and systems to be commissioned are identified in this Section Part 2.

2. The start-up and initial checkout plan shall consist of the following as a minimum:

   a. The manufacturer's standard written start-up and checkout procedures copied from the installation manuals and manufacturer's normally used field checkout sheets. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.
   b. First-run checklist for equipment, to in accordance with the manufacturer recommendations and pre-functional check list determined by the CA.

3. The Commissioning Agent shall determine which trade is responsible for executing and documenting each of the line item tasks and note that trade on the form. Each form may have more than one trade responsible for its execution.

D. The Commissioning Agent shall review and approve the procedures and the format for documenting them, noting any procedures that need to be added.

E. Two weeks prior or startup, the associated Prime Contractor shall schedule startup and checkout with the CA. The execution of the startup and checkout shall be directed and performed by the respective Prime Contractor, in accordance with manufacturer's published procedures and with the approved procedures. The Commissioning Agent shall be present for the associated Prime Contractor's required startup and checkout of all systems and equipment to be commissioned.

F. All Prime Contractor responsible start-up, checkout forms shall be completed and submitted to the CA for review.

3.3 FUNCTIONAL PERFORMANCE TESTS

A. Functional Performance Verification (FPV) is the dynamic testing of systems (rather than just individual components) under full and part load requirements. The systems are run through all the control sequences of operation and components are verified to be responding as the design intent and documents. Functional performance verification shall include testing all sequences of operations, verification of system capacity, generating simulated signals to simulate sensor values, conducting simulated conditions to tests all loads and verify system performance during all conditions of operation and verifying design intent. In addition, each system shall be tested through all modes of operation. Proper responses such as power failures, equipment failures, etc. shall also be tested. The commissioning authority develops the functional test sheets and procedures in sequential written form, coordinates the testing, conducts the testing and documents the testing. Each Prime Contractor is required to supply personnel to assist during the functional performance testing where applicable.

B. No system, equipment or component thereof shall be tested until the respective Prime Contractor and has certified, in writing, that the system, equipment and / or components are complete, have been tested, adjusted and balanced and are ready for validating and performance testing. Functional Performance Verification is scheduled by the commissioning agent after the pre-functional testing requirements are complete and signed-off by the Commissioning Agent. Functional Performance Verification will not be conducted until a written notice of completion by the associated Prime Contractor confirming that the system is ready for FPV. The air balancing and water balancing must be complete, and the controls must be debugged prior to the performance verification.

C. Functional testing shall be conducted by the contract with assistance, coordination, and documentation by the commissioning agent. Functional testing may not proceed until the systems have been properly installed, started-up and all deficiencies have been corrected.

D. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA. Beginning system testing before full completion shall not relieve the associated Prime Contractor from fully completing the system, including all prefunctional checklists.

E. The associated Prime Contractor shall provide personnel to operate the systems while functional performance testing is commencing.

F. The associated Prime Contractor shall review the commissioning functional performance testing procedure supplied by the commissioning agent. After functional testing commences, the associated Prime Contractor and the commissioning agent shall sign the functional test record and provide The Using Agency a copy to review. All deficiencies either corrected in the field or outstanding shall be documented on the functional test forms for review by all parties.

G. All Functional Testing must be completed and approved by the Commissioning Agent and associated Prime Contractor before the project will be considered substantially complete.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

A. The Commissioning Agent shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the testing form or on an attached sheet. The testing form and any outstanding deficiencies shall be provided to associated Prime Contractor within two days of test completion. The Commissioning Agent shall review the respective Prime Contractor's startup testing reports and shall submit either a non-compliance report or an approval form to the respective Prime Contractor. The Commissioning Agent shall work with the Electrical Prime Contractor and associated Prime Contractors as necessary, to correct and retest deficiencies or uncompleted items. The associated Prime Contractor shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Agent as soon as outstanding items have been corrected and resubmit an updated start-up report with a Statement of Correction on the original non-compliance report. When all requirements are satisfactorily completed, the Commissioning Agent shall recommend approval of the startup and prefunctional testing of each system and schedule the functional testing of the equipment or system.

B. As functional performance testing progresses and a deficiency is identified, the Commissioning Agent shall discuss the issue with the executing Prime Contractor and the commissioning team.

1. When there is no dispute of the deficiency and the associated Prime Contractor accepts responsibility for correcting it, the Commissioning Agent shall document the deficiency, response, and intentions. Corrections of minor deficiencies identified may be made by the respective Prime Contractor during the functional performance testing, at the discretion of the Commissioning Agent. Every effort shall be made or expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the commissioning effort.

2. When the identified deficiency is corrected, the associated Prime Contractor shall sign the statement of correction at the bottom of the non-compliance form, certifying that the equipment is ready to be retested, and return the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved.

3. If there is a dispute about an identified deficiency, the Commissioning Agent shall document the deficiency and the associated Prime Contractor's response, and provide a copy to the associated Prime Contractor. Every attempt shall be made to resolve the dispute at the lowest management level possible. When the dispute resolution has been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non-compliance form and returns the form to the Commissioning Agent. The Commissioning Agent shall schedule the retest of the equipment or system involved. Final interpretive authority shall be the Professional. Final acceptance authority shall be The Using Agency.

C. During the functional performance testing of multiple units of similar equipment, the Commissioning Agent will test all of the installed equipment and components identified. If, under such a testing procedure, three or more, identical pieces of equipment (size along does not constitute difference) fail to perform to the requirements of the Contract Documents (electrically or substantively) due to manufacturing defects not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CA. In such case, the associated Prime Contractor shall provide the Commissioning Agent with the following:

1. Within one week of notification from the Commissioning Agent, the associated Prime Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Commissioning Agent within two weeks of the original notice.

2. Within two weeks of the original notification, the associated Prime Contractor shall provide the CA and the Professional a signed and dated, written explanation of the problem, cause of failures, etc. and proposed solution, including full equipment submittals for corrective or replacement equipment, if appropriate. The proposed solution shall not be for less than the specification requirements of the original installation.

3. When approved, two examples of the proposed solution shall be installed by the associated Prime Contractor and the Commissioning Agent shall schedule and conduct functional testing of the proposed solution. Upon completion of the functional testing of the proposed solution, the Commissioning Agent shall recommend the acceptance or disapproval of the proposed solution to The Using Agency.

4. Upon acceptance of the proposed solution by The Using Agency, the associated Prime Contractor shall replace or repair all identical items, at their expenses and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week of approval of the proposed solution.

D. Cost of Retesting

1. The cost for Commissioning Agent and/or Prime Contractor personnel to conduct the retesting of a functional performance testing requirements necessitated because a specific prefunctional or startup test item, reported to have been successfully completed, but found to be incomplete or faulty, shall be the responsibility of the Electrical Prime Contractor.

2. For a deficiency identified during the functional testing, not related to any prefunctional checklist or start-up fault, the Commissioning Agent and PADGS shall direct the retesting of the equipment once at “no charge” for their time. However, all costs for any subsequent retesting shall be the responsibility of the Electrical Prime Contractor.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in backcharges to the responsible party.

3.5 TRAINING OF THE USING AGENCY PERSONNEL

A. The electrical commissioning supervisor shall be responsible for training coordination and scheduling of required training and for ensuring that all required training is completed. The Commissioning Agent shall oversee the content and adequacy of the training of The Using Agency personnel.

B. Prepare and submit a syllabus describing an overview of the program, describing how the program will be conducted, when and where meetings are to be held, names and company affiliations of lecturers, description of contents and outline for each lecture, and recommended reference material and outside reading. Obtain direction from The Using Agency on which operating personnel shall be instructed in each system. Proposed training schedules, materials, and lesson plans shall be submitted to the Commissioning Agent for review of the content and adequacy of the training of The Using Agency personnel for commissioned equipment or systems.

C. Training responsibilities shall include:

1. Provide the Commissioning Agent with training plan one week before the planned training.

2. Provide designated The Using Agency personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment.

4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.

5. The appropriate trade or manufacturer’s representative shall provide the instructions on each major piece of equipment. This person may be the startup technician for the piece of equipment, the installing Prime Contractor or manufacturer’s representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.

6. The controls Prime Contractor shall attend sessions other than the controls training, for each type of equipment controlled by the BAS, to discuss the interaction of the BAS as it relates to the equipment being discussed.

7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.

3.6 WRITTEN WORK PRODUCTS

A. Written work products of Prime Contractors listed in these specifications shall consist of the start-up and initial checkout plan and the filled out start-up, initial checkout and pre-functional checklists.

END OF SECTION 26 0800

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section includes lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

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

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Field quality-control reports.

D. Panelboard schedules for installation in panelboards.

E. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Refer to panel schedules for Surface or recessed -mounted cabinets.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.

C. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Hard-drawn copper, 98 percent conductivity.
   2. Main and Neutral Lugs: Compression type.
   3. Ground Lugs and Bus Configured Terminators: Compression type.

D. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.
   4. Eaton; a brand of Cutler Hammer.

5. ABB; a brand of ASEA Brown Boveri.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Mains: Circuit breaker.

E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in or Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
      c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 72 inches above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box.

D. Install overcurrent protective devices not already factory installed.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

G. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and incorporating Client Agency’s final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, and feeder circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:
1. Perform each visual and HVAC inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 262416

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 STIPULATION

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

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Snap switches.

1.3 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles or as approved by professional:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).
   5. Eaton Wiring Devices; (Eaton)
   6. Arrow Hart Wiring Devices (Arrow Hart)

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, Hospital Grade, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell Pro 8300.
      b. Leviton; 8300-PL.
      c. Pass & Seymour; 8300.
      d. Arrow Hart; AH8300

2.3 GFCI RECEPTACLES

A. General Description: Hospital Grade, Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell GFR 8300H.
      b. Hubbell; GFR8300H_ST.
      c. Leviton; 7899-HG
      d. Pass & Seymour; 2095HG_L.

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Cooper; 2221PL for 120 V and 277 V.
b. Hubbell; HPL1221PL for 120 V and 277 V.
c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 302/304 SS, non-magnetic, stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.

B. Damp or Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover. Listed as “weatherproof while-in-use”.

2.6 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: As selected by professional, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. 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 the 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 just 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.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they 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, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the 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 down, 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. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. 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 not acceptable.
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. The 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, and retest as specified above.

END OF SECTION 262726

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 STIPULATIONS

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

1.2 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Molded-case circuit breakers (MCCBs).
   4. Enclosures.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

C. Field quality-control reports.

D. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.
   4. Eaton; a brand of Cutler Hammer.
   5. ABB; a brand of ASEA Brown Boveri.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, 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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Lugs: Suitable for number, size, and conductor material.
   5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.
   4. Eaton; a brand of Cutler Hammer.
   5. ABB; a brand of ASEA Brown Boveri.

B. Type HD, Heavy Duty, 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: Suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.
4. Eaton; a brand of Cutler Hammer.
5. ABB; a brand of ASEA Brown Boveri.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: 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.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

3.2 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with laminated-plastic nameplate.
   3. Provide label inside enclosure with fuse size and type that is required.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and HVAC inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

END OF SECTION 262816

SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of Contract”, “Special Conditions” and “Division1 – General Requirements” form a 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. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

B. Related Sections:
   1. See Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, occupancy sensors, and multipole lighting contactors.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes.

B. Field quality-control test reports.

1.4 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. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lighting Fixtures
   1. Available Manufacturers: Subject to compliance with requirements, manufacturer offering products that may be incorporated into the Work include, but are not limited to products indicated on the drawings or equal as approved by the Professional.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. 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.

E. 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.
   4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:
   1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
      a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
      b. UV stabilized.
   2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 EXIT SIGNS

A. Internally Lighted Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.4 LED LIGHT FIXTURES

A. General:
   1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
   2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
   3. LED drivers shall include the following features unless otherwise indicated:
      a. Minimum efficiency: 85% at full load.
      b. Minimum Operating Ambient Temperature: -20˚ C. (-4˚ F.)
      c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
      d. Integral short circuit, open circuit, and overload protection.
      e. Power Factor: ≥ 0.95.
      f. Total Harmonic Distortion: ≤ 20%.
      g. Comply with FCC 47 CFR Part 15.
   4. LED modules shall include the following features unless otherwise indicated:
      a. Comply with IES LM-79 and LM-80 requirements.
      b. Minimum CRI 80 and color temperature 3000˚ K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
      c. Minimum Rated Life: 50,000 hours per IES L70.
      d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.

B. LED Downlights:
   1. Housing, LED driver, and LED module shall be products of the same manufacturer.

C. LED Troffers:
   1. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
   2. Housing, LED driver, and LED module shall be products of the same manufacturer.

2.5

2.4 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports.

B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

C. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture supports.

C. Lay-in Ceiling Lighting Fixtures Supports:
1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from each lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two ¾ inch metal channels spanning and secured to ceiling tees.
4. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. 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.

END OF SECTION 265100

SECTION 283111

DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full. Section 9.7 of the General Conditions to the Construction contract does not apply to this item

1.2 RELATED DOCUMENTS

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

1.3 SUMMARY

A. This Section includes fire alarm systems.
   1. Fire-alarm control unit.
   2. Manual fire-alarm boxes.
   3. System smoke detectors.
   4. Heat detectors.
   5. Notification appliances.
   6. Addressable interface device.

B. Related Sections include the following:
   1. Division 08 Section "Door Hardware" for door closers and holders with associated smoke detectors, electric door locks, and release devices that interface with the fire alarm system.

1.4 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: *National Institute for* Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.5 SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded, hardwire/addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, monitoring and control devices as indicated on the drawings and as specified. The existing Siemens Fire Alarm Control Panel shall be replaced to accommodate all new devices and required functions. All new fire alarm initiating devices shall be addressable as specified.

1.6 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72, 2010 Edition

B. Information in paragraph below is typically requested by authorities having jurisdiction, according to NFPA 72, Subsection A-1-5.5.2.1(5).

C. Fire alarm signal initiation shall be by one or more of the following devices:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Verified automatic alarm operation of smoke detectors.

D. Fire alarm signal shall initiate the following actions:
1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciator.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Release fire and smoke doors held open by magnetic door holders.
5. Activate voice/alarm communication system.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
7. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
8. Record events in the system memory.

E. Supervisory signal initiation shall be by one or more of the following devices or actions:
1. Operation of a fire-protection system valve tamper.

F. System trouble signal initiation shall be by one or more of the following devices or actions:
1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at the FACP.
4. Ground or a single break in FACP internal circuits.
5. Abnormal ac voltage at the FACP.
6. A break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at the FACP or annunciator.

G. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators.

1.7 SUBMITTALS

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

B. Shop Drawings:
1. Shop Drawings shall be prepared by persons with the following qualifications:
a. Trained and certified by manufacturer in fire alarm system design.
b. Fire alarm certified by NICET, minimum Level IV.
2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Coordinate with final system programming.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Size calculations.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 01 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Professional for review.

G. Documentation:
1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Client Agency**,** Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Client Agency, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
   a. Hard copies on paper to Client Agency, Professsional, and authorities having jurisdiction.
   b. Electronic media may be provided to Professional.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Work of this Section will be performed by a UL-listed company.

C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level IV.

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.

1.9 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Client Agency or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated.
   1. Notify Department and Client Agency no fewer than five days in advance of proposed interruption of fire alarm service.
   2. Do not proceed with interruption of fire alarm service without Department's and Client Agency's written permission.

1.10 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm devices, remove existing disconnected fire alarm equipment. Retain this Article if Project requires replacement or extension of an existing system in an occupied building. Coordinate with Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Siemens: Upgrade/expand and replacement of existing system.
   1. FACP and Equipment:
      a. Contact Berkshire Systems Inc at 1-800-344-4012
      b. Sales Agent. Jed Richardson, jrichardson@bsci.com
   2. Wire and Cable:
      a. Comtran Corporation.
      b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
      c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
      d. West Penn Wire/CDT; a division of Cable Design Technologies.

B. The above item has been approved by the Department as a proprietary item. No other items will be accepted. Article 9, paragraph 9.6 Substitution of Materials, of the General Conditions to the Construction Contract does not apply to the above item.

2.2 EXISTING FIRE ALARM SYSTEM

A. Compatibility with Existing Campus Equipment: Fire alarm system and components shall operate as an extension of the existing system.

2.3 FACP

A. General Description:
1. Provide all necessary modules, interfaces, upgrades, etc. to connect new equipment to existing fire alarm control panel.

B. Circuits:
1. Class and style of circuits shall match existing.

2. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

C. Notification-Appliance Circuit: Match existing.

2.4 MANUAL FIRE ALARM PULL STATIONS

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. General Description:
1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Multipurpose type, containing the following:
   a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
   b. Piezoelectric sounder rated at 88 dBA at 10 feet according to UL 464.
   c. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
   a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:
1. Photoelectric Smoke Detectors:
   a. Sensor: LED or infrared light source with matching silicon-cell receiver.
   b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
   c. Air Velocity Rating: 100 to 4000 feet per minute.
   d. Warranty: 3 year
   e. Powered outputs for removed LED and remote test.

f. Four (4) form "C" auxiliary contacts.
   1) (1) set for fire alarm “alarm” signal
   2) (1) set for fire alarm “trouble” signal
   3) (1) set for ATC panel
   4) (1) set for unit shut down
g. Communication line with power compatible 24 VAC/DC or 120/220 VAC.
h. Detector to be an intelligent photoelectric detector specifically designed for use in air handling systems. Detector sensitivity changes caused by dirt, temperature or humidity are compensated by the control panel compensation algorithms to maintain constant sensitivity.
i. Airtight smoke chamber in compliance with U.L.
j. Voltage: 15 to 32 VDV
k. Operating Temperature: 0 F to 120 F.
l. Operating Humidity Range: 10% to 93% relative humidity

2. UL 268A listed, operating at 24-V dc, nominal. U.L. recognized field receptacle power and sensor boards.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X. Housing shall be designed to circulate conditioned air from the air duct to help maintain sensor housing at its rated temperature range.
   b. Provide sheet metal or equivalent canopy for duct housing to prevent direct sunlight to unit.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.
   1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
   1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.7 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
   2. Device color shall be red.

B. Visible Alarm Device: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
   1. Rated Light Output: 15 / 30 / 75 / 110 candela, selectable in field.
   2. Strobe Leads: Factory connected to screw terminals.

C. Horn/Visual : Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

2.8 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

2.9 POWER EXTENDERS

A. Provide power extenders as necessary to provide additional power for auxiliary alarms and notification appliances. Coordinate mounting locations with Engineer. There shall be a spot type smoke detector installed within 15 feet of all power extenders.

2.10 GUARDS FOR PHYSICAL PROTECTION

A. Description: Clear tamperproof polycarbonate shield and frame. STI Stopper II.

B. Provide wire guards for all smoke detectors.

C. All guards shall be listed for use with the device they are protecting. Install per manufacturers instructions.

2.11 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPL, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:
1. Smooth ceiling spacing shall not exceed 30 feet.

2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct.

D. Remote Status and Alarm Indicators: Install near each duct detector that is not readily visible from normal viewing position.

E. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

F. Device Location-Indicating Lights: Locate in public space near the device they monitor.

G. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.

H. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated complete EMT, (with red markers) raceway system. This system shall not be used for any other wire or cable. EMT shall be red factory painted.
2. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
3. Fire-Rated Cables: Use of 2-hour fire-rated fire alarm cables, NFPA 70 Types MI and CI, is not permitted.

4. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 SUPPLEMENTAL EQUIPMENT AND OPERATIONAL REQUIREMENTS

A. Run all fire alarm initiating and indicating device wiring, including multiple (3) addressable wiring loops in conduit to the fire alarm control panel. Make all final wiring terminations and supply all ancillary equipment in order to provide a complete and operable system.

B. Provide all required auxiliary contacts and all wiring in conduit to the elevator controller for fireman's and emergency return service. Provide auxiliary contacts at elevator shaft smoke detectors and interface wiring in conduit to the elevator roof smoke vent. Make all final connections to smoke vent. In the event of a power outage, elevator shall be recalled to first floor and doors commanded to open position.

C. Upon activation of a manual fire alarm station, the following actions shall occur:
   1. Sound an audible alarm throughout the facility.
   2. Activate the strobe lights throughout the facility
   3. Indicate the point in alarm at the command center display and print point.
   4. Activate municipal trip for "manual station".
   5. Release all electric door locks at secured doors through an interface with the security system equipment.
   6. Shutdown all HVAC units, fans, etc. with the exception of air conditioning units in the IDF closets, security control room, security equipment room and PBX room. Activation of local detectors in the IDF closets, security control room, security equipment room, PBX room, and any exhaust fans serving process areas will shutdown these devices.

D. Upon activation of an area smoke detector, area heat detector, duct detector or sub-system alarm contact, the following actions shall occur:
   1. Initiate a 30 sec. alarm verification timer for the device.
   2. Sound an audible alarm throughout the facility.
   3. Activate the strobe lights throughout the facility.
   4. Indicate the point in alarm at the command center. Display and print point in alarm command center.
   5. Activate municipal trip for "automatic device".
   6. Shutdown all HVAC units, fans, smoke dampers, etc. with the exception of air conditioning units in the IDF closets, security control room, security equipment room and PBX room. Activation of local detectors in the IDF closets, security control room, security equipment room, PBX room, and any exhaust fans serving process areas will shutdown these devices.
   7. Release all electric door locks at secured doors through an interface with the door hardware or access control equipment.

8. Shutdown of air handlers shall be accomplished directly through the starter control circuit not via the building management system.

E. Upon activation of a "master alarm" switch at the fire command station, the following shall occur:
1. Sound an audible alarm throughout the facility.
2. Activate the strobe lights throughout the facility.
3. Release all electric door locks at secured doors through an interface with the security system equipment.

F. Provide fault isolation modules after every 20 devices on all addressable wiring loops. Provide end of line resistors, end of line relays, monitor and control modules, and fan shutdown relays, based on quantities of devices indicated or required.

G. Provide signal expander panels and all ancillary equipment required where horn and strobe circuits exceed manufacturer recommended distance limitations. Coordinate locations with engineer during equipment submittal phase of project.

H. Provide all ancillary equipment at fire alarm panel for interface with security door release system and fan shutdown as described in notes 3, 4, and 5. Division 26 Contractor is solely responsible for coordinating all wiring in conduit, voltage requirements, etc. required to provide a complete operable system.

I. Two start and stop relays and one status relay shall be provided by the Division 26 Contractor at each packaged rooftop air conditioning unit provided under Division 23 connected to the rooftop air conditioning unit shutdown system. Coordinate installation locations and interfacing of relays with Division 23 Contractor.

3.6 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. Testing Agency: Client Agency will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:
   1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
   2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
      a. Include the existing system in tests and inspections.
   3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
   4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
      a. Detectors that are outside their marked sensitivity range shall be replaced.
   5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.

C. Semiannual Test and Inspection: Six months after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

D. Annual Test and Inspection: One year after date of Substantial Completion, test the fire alarm system complying with the testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for monthly, quarterly, semiannual, and annual periods. Use forms developed for initial tests and inspections.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Client Agency's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 01 Section "Closeout Procedures."

END OF SECTION 283111