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PROJECT MANUAL

VOLUME 03 OF 04 : DIVISIONS 21-34

Pawling Central School District

2020 Capital Project - Phase 3

Pawling Elementary School: SED No. 13-12-01-04-0-001-024

CSArch Project No. 208-2101.03

The design of this project conforms to applicable provisions of the New York State Uniform Fire Prevention and Building Code, the New York State Energy Conservation Construction Code, and the Manual of Planning Standards of the New York State Education Department

CSARCH

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SECTION 220500 – COMMON PLUMBING REQUIREMENTS

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 and all Division 22 Sections.

1.2 PLANS AND SPECIFICATIONS

A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.

B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.

C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term “Contractor” or “PC” appears, it shall imply the Contractor responsible for Division 22, Plumbing Work.

1.3 CONFLICTS

A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.

B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.

B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.

C. Layouts of piping, and equipment shown on drawings are diagrammatic. Contractor shall verify dimensions and layouts for specific project conditions, field verify any existing conditions, and coordinate with all other trades prior to procurement, fabrication and installation of equipment and material. Existing Conditions shall be field verified by contractor prior to bid submissions. Unknown conditions during construction due to omission of contractor field verification prior to bid shall be resolved by the contractor at no cost to the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

D. Make actual installations in accord with design layouts, but with necessary adjustments as determined by trade coordination, actual material and equipment procured, field verifications, and other project conditions in order to provide a fully functional and complete system, save and maintainable in all aspects. Any such required adjustments and deviations shall require specific approval of the Engineer/Architect prior to procurement, fabrication, and installation.

E. Take particular care to coordinate all piping and equipment under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner or project.

F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping and related items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.

G. The Owner or Owner's Representative reserves the right to relocate Fixtures and equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

1.5 REVIEW OF PROPOSED EQUIPMENT AND MATERIALS

A. Submittals:
   1. Contractor shall submit a complete list and schedule, including all proposed equipment and materials to the Construction Manager or Owner’s Representative and Engineer for review and approval within 10 business days of contract award.

B. Submit all proposed material, equipment, and fabrication shop drawings to the Engineer for approval prior to procurement, fabrication, and installation.

C. Substitution Requests:

1. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.

2. In addition to other contract provisions regarding substitution requests, Contactor must certify by letter that he has checked the proposed substitution products or materials for conformance to applicable codes, standards, and regulations, specifications, and space limitations and assumes full responsibility thereafter.

3. Approval of substitution requests is at the sole discretion of the Engineer and Owner.

4. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.

5. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner or Project, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

1.6 PERMITS, CODES AND ORDINANCES

A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.

B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

1.7 QUALITY ASSURANCE

A. Install Plumbing Systems in accordance with applicable industry standards.

B. All materials within domestic water distribution systems that may come in contact with potable water delivered shall comply with ANSI/NSF Standard 61: Drinking Water System Components – Health Effects.

C. Install Plumbing Systems in accordance with manufacturer's installation, operations and maintenance instructions.

D. Prior to putting any potable water fixture currently or potentially used for drinking or cooking purposes, including but not limited to a bubbler, drinking fountain, or faucets.in operation, perform a "first draw" sampling of the water in accordance with 10 NYCRR subpart 67-4. First-draw samples shall be collected from all outlets, as defined in this Subpart. A first-draw sample volume shall be 250 milliliters (mL), collected from a cold water outlet before any water is used. All first-draw samples shall be analyzed by a laboratory approved to perform such analyses by the New York State Department of Health's Environmental Laboratory Approval Program (ELAP). The water shall be motionless in the pipes for a minimum of 8 hours, but not more than 18 hours, before sample collection. The construction manager or owner's representative and owner shall be notified of any sample indicating a lead level of 15 micrograms per liter (equivalent to parts per billion, or ppb). Any potable water fixture connected to any such tested branch piping shall be taken out of service and conspicuous notice shall be made that the fixture is "OUT OF SERVICE".

1.8 COORDINATION WITH OTHER TRADES

A. Check plumbing work with all other trades.

B. Anticipate, avoid, and resolve interferences with other trades.

C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner.

D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.

E. The Contractor shall coordinate with, receive and install, Owner furnished equipment where indicated.

F. Coordinate location of controls and instrumentation devices, including but not limited to control valves, thermowells, pressure probes, insertion flow meters, and ultrasonic flow meters, with Building Automation System (BAS) requirements. Provide installation of controls and instrumentation devices furnished as part of the BAS.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor, and assume full responsibility for all materials while in storage with full visible identification and information.

1.10 PROJECT CONDITIONS

A. Coordination: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for change orders and additional costs incurred by the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

A. Existing facilities shall be considered occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.11 MISCELLANEOUS SUPPORT

A. Contractor is responsible for providing all miscellaneous support components necessary for properly supporting Plumbing Systems including hangers, rods, anchors, steel, and bases.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 COMMON PLUMBING SYSTEMS INSTALLATION REQUIREMENTS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of Plumbing systems.

B. Indicated locations and arrangements were used to size systems and address other design considerations. Install systems as indicated unless deviations to layout are approved by Architect and Engineer.

C. Install systems in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install systems indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

F. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

G. Diagonal runs of piping are prohibited unless specifically indicated otherwise.

H. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.

I. Install systems and 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.

J. Install equipment with all required manufacturer's service clearances maintained.

K. Install piping at indicated slopes.

L. Install piping free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install systems to allow application of insulation.

O. Select system components with pressure rating equal to or greater than system operating pressure.

P. Install escutcheons for penetrations of walls, ceilings, and floors.

Q. Running piping over electrical equipment and in elevator machine rooms is prohibited.

R. Running piping into or through interior exit stairways, other than systems serving such stairwells as permitted by the International Building Code, is prohibited.

S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Such Penetrations shall be sealed with firestop materials.

T. Install Plumbing Systems on required supports and bases meeting maximum allowable spans and sized for the specific loads.

U. Install controls and instrumentation devices for Plumbing Systems required for system operations and as indicated.

END OF SECTION 220500

SECTION 220502 – COMMON PLUMBING DEMOLITION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Description of Work: Provide plumbing removal work as indicated and as required for removal and/or abandonment of systems, equipment and fixtures, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

A. Existing plumbing systems, equipment and fixtures may not all be shown on the Drawings. Existing conditions, where indicated, are based on preliminary field observations and/or existing conditions documentation made available to the Architect and Engineer and must be verified. Report any discrepancies to the Architect and Engineer before disturbing the existing installation.

B. Prior to bidding, examine the site to determine all actual observable conditions. Additional work or scope changes due to the Contractor's failure to investigate such existing conditions shall not be grounds for change orders or cause additional costs to the owner and project.

1.3 COORDINATION

A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and Plumbing Systems and services must remain in operation at all times, unless specifically approved otherwise.

B. Scheduling: Demolition work and any required shut-downs shall be scheduled in conjunction with all other trades and the owner. Contractor cooperation will be expected under all conditions.

C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Construction Manager and Owner.

D. Coordinate and ensure that all equipment affected by the work is de-energized and electrically disconnected by a qualified and authorized contractor or owner's representative prior to proceeding with demolition.

1.4 ADJACENT MATERIALS

A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.

B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

A. Locate and identify any and all services passing through the project area which serve areas outside the work limits.

B. Maintain all services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Architect and Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.

B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing plumbing materials and equipment at the project site.

3.2 DEMOLITION

A. General: Remove plumbing equipment, piping, fixtures and related materials within the project work limits, as indicated.

B. Disconnections: Disconnect all plumbing work located in walls, ceilings or floors scheduled for removal. Disconnect plumbing connections to equipment being removed by other trades.

C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.

D. Patching: When plumbing materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

3.3 EXISTING PLUMBING WORK TO REMAIN

A. General: Protect and maintain access to existing systems which must remain. Reinstall existing systems disturbed.

B. Reconnections: Where systems in adjoining areas or indicated to remain, become disconnected or affected by demolition work, they shall be reconnected as required to restore original operation. Restoration work shall comply with requirements for new work.

3.4 EXISTING PLUMBING WORK TO BE RELOCATED

A. General: Disconnect, remove, reinstall and reconnect equipment indicated to be relocated and where required to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions shall conform to requirements for new work.

3.5 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.

B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.

C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.6 CLEANING

A. Remove from the Project Site all dirt, dust and debris resulting from removal operations daily. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 220502

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

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

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC.

B. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.

3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Stainless steel.
5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

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

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

a. Dow Corning Corporation.
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. Polymeric Systems, Inc.
d. Schnee-Morehead, Inc., an ITW company.
e. Sherwin-Williams Company (The).

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop

materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Sleeve-seal fittings.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
    b. Piping NPS 6 and Larger: Stack-sleeve fittings.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6: Steel pipe sleeves.
    b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).
5. Mid-America Fittings, Inc.
6. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

2.3 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece cast brass or split-casting brass with polished, chrome-plated finish.
c. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

a. Chrome-Plated Piping: Split-casting, stamped steel with concealed hinge with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

SECTION 220523.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.18 for solder-joint connections.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. 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 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port, and Stainless-Steel Trim, Press Ends:

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

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. Hammond Valve.

d. Milwaukee Valve Company.
e. NIBCO INC.
f. Viega LLC.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Press.
f. Press Ends Connections Rating: Minimum 200 psig.
g. Seats: PTFE or RTPFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel.
j. Port: Full.
k. O-Ring Seal: EPDM or Buna-N.

B. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

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

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Center Line; a Crane Co. brand.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Viega LLC.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded or soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 3: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded solder or press connection-joint ends.

B. Pipe NPS 2-1/2 and Larger:

1. Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded solder or press connection-joint ends.

END OF SECTION 220523.12

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Iron, single-flange butterfly valves.
2. Iron, grooved-end butterfly valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

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.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 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 B16.5 for flanges on steel valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.9 for building service piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 (DN 200) and larger.
2. Handlever: For valves NPS 6 (DN 150) and smaller.

H. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:

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

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Jenkins Valves; a Crane Co. brand.

c. KITZ Corporation.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating, NPS 12 (DN 300) and Smaller: 200 psig (1380 kPa).
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: Stainless steel.

2.3 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Ductile Iron, Grooved-End Butterfly Valves, 175 CWP:

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

a. Tyco by Johnson Controls Company.
b. Victaulic Company.
c. Zurn Industries, LLC.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig (1200 kPa).
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags.

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 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, stainless-steel disc.
2. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

END OF SECTION 220523.13

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Metal framing systems.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Pipe-positioning systems.
7. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Metal framing systems.
2. Pipe stands.
3. Equipment supports.

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. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

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.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

a. ABB, Electrification Business.
b. Flex-Strut Inc.
c. G-Strut.
d. Haydon Corporation.
e. Unistrut; Atkore International.

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: Hot-dip galvanized.

2.4 THERMAL HANGER-SHIELD INSERTS

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

1. CADDY; brand of nVent Electrical plc.
2. Carpenter & Paterson, Inc.
3. National Pipe Hanger Corporation.
4. Pipe Shields Inc.
5. Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. 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. Cooper B-line; brand of Eaton, Electrical Sector.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated steel.
3. Outdoor Applications: Stainless steel.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.

3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
5. Pipe Supports: Roller.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads.

8. Height: 12 inches (300 mm) above roof.

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: One adjustable-height, galvanized- or stainless-steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller.
6. Hardware: Galvanized steel.
7. Height: 36 inches (900 mm) above roof.

2.7 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.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M).

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. MetalFraming System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe Stand Installation:

   1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb..

F. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. 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.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. 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 MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C) pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
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 (DN 100 to DN 900), 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 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), 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 (DN 50 to DN 1050) 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) 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 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. 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. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.2 ACTION SUBMITTALS

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

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Champion America.
d. Craftmark Pipe Markers.
e. Kolbi Pipe Marker Co.
f. Marking Services, Inc.

g. Seton Identification Products; a Brady Corporation company.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

3. Letter Color: White.
4. Background Color: Red.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
7. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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 rivets or 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 (A4) 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. Brimar Industries, Inc.
3. Champion America.
4. Craftmark Pipe Markers.
5. Marking Services Inc.
6. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

G. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), 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 rivets or 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. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Champion America.
5. Craftmark Pipe Markers.
6. Kolbi Pipe Marker Co.
7. Marking Services Inc.
8. Seton Identification Products; a Brady Corporation company.

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 cover full 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 At least 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.

2.4 VALVE TAGS

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

1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Champion America.
5. Craftmark Pipe Markers.
6. Kolbi Pipe Marker Co.
7. Marking Services Inc.
8. Seton Identification Products; a Brady Corporation company.

B. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or S-hook.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Kolbi Pipe Marker Co.
5. Marking Services Inc.
6. Seton Identification Products; a Brady Corporation company.
7.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, 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 25 feet (7.6 m) along each run. Reduce intervals to 15 feet (4.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. High-Pressure Compressed Air Piping:

    a. Background: Safety blue.
    b. Letter Colors: White.

2. Domestic Water Piping

    a. Background: Safety green.
    b. Letter Colors: White.

3. Sanitary Waste and Storm Drainage Piping:

    a. Background Color: Safety gray.
    b. Letter Color: Black.

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 similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 1-1/2 inches (38 mm), round.
   b. Hot Water: 1-1/2 inches (38 mm), round.

2. Valve-Tag Colors:

   a. Cold Water: Natural.
   b. Hot Water: Natural.

3. Letter Colors:

   a. Cold Water: White.
   b. Hot Water: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

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 insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields.

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.

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

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

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.

2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.

3. 850 deg F.
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

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. Ramco Insulation, Inc.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

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. Ramco Insulation, Inc.

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 Adhesive: Solvent-based adhesive.

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

    a. Aeroflex USA.
    b. Armacell LLC.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. K-Flex USA.
2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.
5. Color: Black.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. P.I.C. Plastics, Inc.
    c. Proto Corporation.
    d. Speedline Corporation.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

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. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.
5. Service Temperature Range: Minus 20 to plus 180 deg F.
6. Color: White.

2.5 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

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

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.
d. Owens Corning.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

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. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

B. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

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. Childers Brand; H. B. Fuller Construction Products.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
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 C1136.

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

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

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. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. 3M Industrial Adhesives and Tapes Division.
    b. Ideal Tape Co., Inc., an American Biltrite Company.
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.

2.10 SECUREMENTS

A. Bands:

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. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

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

    a. Buckaroos, Inc.
    b. McGuire Manufacturing.
    c. Truebro; IPS Corporation.
    d. Zurn Industries, LLC.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures,:

1. 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. Truebro; IPS Corporation.
   b. Zurn Industries, LLC.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, 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 storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 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 in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece 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 of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a

breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation 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 that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install 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 that of 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.

3.7 INSTALLATION OF MINERAL-FIBER 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 that of 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 that of 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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. 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.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

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. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1and Smaller: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 1-1/4 and Larger: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 30 mils thick.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.

B. This section defines the commissioning responsibilities of the Division 22 Contractor and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.

C. This section includes additional commissioning process requirements for the following plumbing systems, assemblies and equipment. This list of Systems to be Commissioned may be modified as described in 019113 "General Commissioning Requirements." The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.
   1. Thermostatic Mixing Valves.
   2. Balancing Valves.
   3. Electronic Faucets.
   4. Electronic Flushometers.

D. Related Requirements:
   1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.

E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
   1. A/E: Architects and Engineers
   2. Cx: Commissioning
   3. CxA: Commissioning Authority
   4. Cx Plan: Commissioning Plan Document

5. FT: Functional Performance Test
6. PFI: Pre-Functional Inspection
7. TAB: Test and Balance Contractor

1.2 INFORMATIONAL SUBMITTALS

A. Prefunctional Checklists

1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

B. Startup and Manufacturer Test Reports

1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.

C. Requests for Clarification

1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the contractor shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MEETINGS

A. Attend commissioning meetings as described in the General Commissioning Requirements.

B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the construction manager or owner's representative and CxA.

3.2 COORDINATION AND SCHEDULING

A. The contractor shall coordinate schedule for prefunctional checklists and equipment startup with CxA.

B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

3.3 PREFUNCTIONAL CHECKLISTS

A. Blank copies of the required checklists will be provided by the CxA for use by the contractor.

B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the contractor on equipment provided by the contractor) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.

D. The contractor shall submit any requests for direction on completion of checklists in writing to the construction manager or owner's representative and CxA.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.

B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.

C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).

D. The contractor shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.

E. General testing requirements:

1. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
2. Certify that plumbing instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

3.5 SEASONAL TESTING

A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the contractor shall provide qualified personnel to assist with execution of tests. Where required, the contractor shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

3.6 MANUFACTURER'S FIELD SERVICE

A. Where required in these specifications, the contractor shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").

B. The contractor shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and

schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.

C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.

D. Following correction of deficiencies, the contractor shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

A. The contractor shall be responsible for responding and addressing deficiencies or items of non-conformance related to the system.

B. Where deficiencies are identified during the commissioning process, the contractor shall issue a written response.

C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.

D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.

E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

3.8 OWNER TRAINING

A. Training shall be provided by the contractor in coordination with the Owner, construction manager or owner's representative and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

3.9 PERSONNEL

A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION 22 08 00

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Transition fittings.
4. Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. System purging and disinfecting activities report.

C. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Construction Manager or Owner's Representative and Owner no fewer than 7 days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's or Owners Representative's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

F. Wrought Copper Unions: ASME B16.22.

G. Grooved, Mechanical-Joint, Copper Tube Appurtenances:

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

a. Grinnell G-Fire by Johnson Controls Company.
b. Shurjoint-Apollo Piping Products USA Inc.
c. Victaulic Company.

2. Grooved-End, Copper Fittings: ASTM B75 copper tube or ASTM B584 bronze castings.
3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F, for use with ferrous housing and steel bolts and nuts; 300 psigminimum CWP pressure rating.

H. Copper Tube, Pressure-Seal-Joint Fittings:

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

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Elkhart Products Corporation.
   c. NIBCO INC.
   d. Viega LLC.

2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F.

2.3 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 B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

2.4 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

a. Dresser, Inc.
b. Jay R. Smith Mfg Co; a division of Morris Group International.
c. JCM Industries, Inc.
d. Smith-Blair, Inc.
e. Viking Johnson.

2.5 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. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. HART Industrial Unions, LLC.
d. Jomar Valve.
e. WATTS.
f. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig minimum at 180 deg F.
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. Capitol Manufacturing Company.
b. Matco-Norca.
c. WATTS.

d. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
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. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

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. Elster Perfection Corporation.
b. Grinnell G-Fire by Johnson Controls Company.
c. Precision Plumbing Products.
d. Sioux Chief Manufacturing Company, Inc.
e. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
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 APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Aboveground domestic water piping,, shall be one of the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; 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.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install 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.

M. Install thermostats in hot-water circulation piping.

N. Install thermometers on outlet piping from each water heater.

O. Install sleeves for piping penetrations of walls, ceilings, and floors.

P. Install sleeve seals for piping penetrations of concrete walls and slabs.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 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. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

E. 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.

F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

3.5 INSTALLATION OF DIELECTRIC FITTINGS

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.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 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.

3.9 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. Hydrostatic testing and documentation of test results for polypropylene piping to be in accordance with the manufacturer's instructions and submitted to the manufacturer upon successful completion per warranty requirements.
f. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
g. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 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.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Strainers for domestic water piping.
5. Outlet boxes.
6. Hose bibbs.
7. Wall hydrants.
8. Ground hydrants.
9. Post hydrants.
10. Roof hydrants.
11. Drain valves.
12. Water-hammer arresters.
13. Trap-seal primer device.
14. Trap-seal primer systems.
15. Flexible connectors.

1.2 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

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

1.4 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

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

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. WATTS.
   c. Zurn Industries, LLC.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), 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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. MIFAB, Inc.
   c. WATTS.
   d. Zurn Industries, LLC.

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.

C. Laboratory-Faucet Vacuum Breakers:

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

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. WATTS.
   c. Zurn Industries, LLC.

2. Standard: ASSE 1035.
3. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

2.4 BALANCING VALVES

A. Thermostatic Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Caleffi North America.
   b. Circuit Solver.
   c. Danfoss.

2. Flow Regulation: Fully automatic regulate flow based on water temperature. Bypass minimum flow when valve is fully closed.
3. Pressure Rating: 200 psig (1380 kPa).
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscale polymer.
7. End Connections: Threaded or solder joint.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

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

    a. Acorn Engineering Company; a Division of Morris Group International.
    b. Leonard Valve Company.
    c. POWERS; A WATTS Brand.
    d. Symmons Industries, Inc.
    e. Zurn Industries, LLC.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110 deg F (43 deg C).
9. Tempered-Water Design Flow Rate: 0.5-1.5 gpm (0.03-0.09 L/s).
10. Valve Finish: Chrome plated or Rough bronze.

B. Individual-Fixture, Water Tempering Valves:

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

    a. Acorn Engineering Company; a Division of Morris Group International.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. POWERS; A WATTS Brand.
    e. Zurn Industries, LLC.

2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Material: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Connections: Threaded inlets and outlet.
7. Finish: Chrome plated.
8. Tempered-Water Setting: 110 deg F (43 deg C).
9. Tempered-Water Design Flow Rate: Insert 0.5-1.5 gpm (0.03-0.09 L/s).

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

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

    a. Metraflex.
    b. Nibco.
    c. Titan Flow Control, Inc.
    d. WATTS.
    e. Zurn Industries, LLC.

2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
4. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
    b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
    c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).

7. Drain: Factory-installed, hose-end drain valve.

2.7 HOSE BIBBS

A. Hose Bibbs:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. MIFAB, Inc.
c. Prier Products, Inc.
d. WATTS.
e. Zurn Industries, LLC.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. WATTS.
e. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).

7. Outlet, Concealed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet, Exposed: With integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): One with each wall hydrant.

B. Moderate-Climate Wall Hydrants:

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

    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. MIFAB, Inc.
    c. WATTS.
    d. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Loose key.
5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
6. Outlet, Concealed:

    a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7.

7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet, Exposed:

    a. With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7.

10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Key(s): One with each wall hydrant.

2.9 ROOF HYDRANTS

A. Nonfreeze, Draining-Type Roof Hydrants:

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

    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. MIFAB, Inc.
    c. Prier Products, Inc.
    d. WATTS.
    e. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M.
3. Type: Nonfreeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
4. Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
5. Inlet: NPS 3/4 (DN 20).
6. Outlet: Garden-hose thread complying with ASME B1.20.7.
7. Vacuum Breaker:

    a. Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.

2.10 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

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

    a. AMTROL, Inc.
    b. Jay R. Smith Mfg Co; a division of Morris Group International.
    c. Precision Plumbing Products.
    d. Sioux Chief Manufacturing Company, Inc.
    e. WATTS.
    f. Zurn Industries, LLC.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.12 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.
2. Mason Industries, Inc.
3. Metraflex Company (The).

B. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

B. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

C. Y-Pattern Strainers: For water, install on supply side of each control valve water pressure-reducing valve solenoid valve and pump.

D. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.

E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Balancing valves.
3. Temperature-actuated, water mixing valves.
4. Wall hydrants.
5. Roof hydrants.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.5 ADJUSTING

A. Set field-adjustable flow set points of balancing valves.

B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

C. Adjust each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Copper tube and fittings.
4. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

1. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager or Owner’s Representative and Owner no fewer than 7 days in advance of proposed interruption of sanitary waste service.

2. Do not proceed with interruption of sanitary waste service without Construction Manager's or Owner's Representative's and Owner's written permission.

1.6 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 74, Extra Heavy class.

C. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. Heavy-Duty, Hubless-Piping Couplings:

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

a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. MIFAB, Inc.
d. Mission Rubber Company, LLC; a division of MCP Industries.
e. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

E. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Shielded, Nonpressure Transition Couplings:

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) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. End Connections: Same size as and compatible with pipes to be joined.

3. Pressure Transition Couplings:

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

1) Apollo Valves; a part of Aalberts Integrated Piping Systems.
2) Cascade Waterworks Mfg. Co.
3) EBAA Iron, Inc.
4) JCM Industries, Inc.
5) Romac Industries, Inc.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. Dielectric Unions:

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

1) A.Y. McDonald Mfg. Co.
2) Capitol Manufacturing Company.
3) HART Industrial Unions, LLC.
4) Jomar Valve.
5) WATTS.
6) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

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

1) Capitol Manufacturing Company.
2) Matco-Norca.
3) WATTS.
4) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig minimum at 180 deg F.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

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

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) GPT; a division of EnPRO Industries.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

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

1) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
2) Elster Perfection; a Honeywell Company.
3) Matco-Norca.
4) Precision Plumbing Products.

b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 .

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. 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. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Sanitary Waste: 2 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. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

P. 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.

2. Install drains in sanitary waste gravity-flow piping.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
    c. Do not use pipe sections that have cracked or open welds.

D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for pipe hanger and support devices and installation as specified.

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments including crawlspaces.
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 including crawlspaces.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet 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 soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical runs of soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

3.8 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 according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced 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-foot 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.

3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping shall be the following:
1. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, vent piping shall be the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

D. Underground, soil, waste, and vent piping shall be the following:

1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Cleanouts.
   2. Miscellaneous sanitary drainage piping specialties.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

   1. Show fabrication and installation details for frost-resistant vent terminals.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

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

      a. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. WATTS.

d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.

3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. WATTS.
d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M for adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Stainless steel.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Extra-Heavy Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. WATTS.
d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:

    a. Brass.
    b. Countersunk head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

    a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
    b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

B. Floor-Drain, Inline Trap Seal:

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

    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. Josam Company.
    c. RectorSeal Plumbing; A CSW Industrials Company.
    d. Zurn Industries, LLC.

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

C. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install deep-seal traps on floor drains and other waste outlets, if indicated.

E. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

F. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

G. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

H. Install wood-blocking reinforcement for wall-mounting-type specialties.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Install piping adjacent to equipment, to allow service and maintenance.

3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221319.13 - SANITARY DRAINS

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. Floor drains.
2. Floor sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Wade; a subsidiary of McWane Inc.
c. WATTS.
d. Zurn Industries, LLC.

2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required.
5. Anchor Flange: Not required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Not required.
9. Sediment Bucket: Not required.
10. Top or Strainer Material: Stainless steel.
11. Top Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Trap Material: Cast iron.
14. Trap Pattern: Deep-seal P-trap.
15. Trap Features: Cleanout and trap seal.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:

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

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Josam Company.
   c. WATTS.
   d. Zurn Industries, LLC.

2. Standard: ASME A112.6.7.

3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required , with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Internal Strainer: Dome.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: Cast iron, loose.
12. Top of Body and Grate Finish: Acid-resistant enamel.
13. Top Shape: Square.
14. Top Loading Classification: No traffic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319.13

SECTION 221323 - SANITARY WASTE INTERCEPTORS

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. Grease interceptors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of interceptor. Include materials of fabrication, dimensions, rated capacities, retention capacities, operating characteristics, size and location of each pipe connection, furnished specialties, and accessories.

B. Shop Drawings: For each type and size of precast concrete interceptor indicated.

1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Piping connections. Include size, location, and elevation of each.
2. Interface with underground structures and utility services.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only

after arranging to provide temporary sewer services according to requirements indicated:

1. Notify Architect, Construction Manager, and Owner no fewer than seven days in advance of proposed interruption of service.
2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 - PRODUCTS

2.1 GREASE INTERCEPTORS

A. Steel Grease Interceptors GI:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg. Co.
   b. Watts; a Watts Water Technologies company.
   c. Zurn Industries, LLC.
2. Standard: ASME A112.14.3 and PDI-G101, for intercepting and retaining fats, oils, and greases from food-preparation wastewater.
3. Plumbing and Drainage Institute Seal: Required.
4. Body Material: Cast iron or steel.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Corrosion-resistant enamel.
7. Body Extension: Required.

B. Capacities and Characteristics:

1. Length by Width by Depth: 24-1/2 by 36 by 21-1/2 inches.
2. Number of Compartments: Two.
3. Flow Rate: 50 GPM.
4. Retention Capacity: 100 Lbs.
5. Inlet and Outlet Pipe Size: 3 inch NPS.
6. End Connections: Threaded.
7. Cleanout: Integral.
8. Trapped Outlet Required: Yes.
9. Vent Pipe Size: 2 inch.
10. Mounting: Recessed, flush with floor.
11. Flow-Control Fitting: Not required.
12. Operation: Semiautomatic, manual drawoff.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:

1. Install grease interceptors on cast-in-place concrete equipment base(s).

B. Install precast concrete interceptors according to ASTM C 891.

C. Set interceptors level and plumb.

D. Set metal interceptors level and plumb.

E. Install piping and oil storage tanks according to Section 231113 "Facility Fuel-Oil Piping."

F. Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.
2. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
3. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.

3.2 CONNECTIONS

A. Make piping connections between interceptors and piping systems.

3.3 IDENTIFICATION

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Grease interceptors.

3.4 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 221323

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall-mounted water closets.
   2. Flushometer valves.
   3. Toilet seats.
   4. Supports.

1.2 ACTION SUBMITTALS

A. Product Data:

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

A. Water Closets - Floor Mounted, Bottom Outlet, Top Spud: .

1. Manufacturer: Zurn Industries, LLC
2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

a. Material: Vitreous china.
b. Type: Siphon jet.
c. Style: Flushometer valve.
d. Rim Height: 15”
e. Rim Contour: Elongated.
f. Water Consumption: 1.28 gal. per flush.
g. Spud Size and Location: NPS 1-1/2; top.
h. Color: White.

2.3 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud: .

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

a. American Standard.
b. Kohler Co.
c. Mansfield Plumbing Products LLC.
d. Sloan Valve Company.
e. TOTO USA, INC.
f. Zurn Industries, LLC.

2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

a. Material: Vitreous china.
b. Type: Siphon jet.
c. Style: Flushometer valve.
d. Rim Contour: Elongated.
e. Water Consumption: 1.28 gal. per flush.
f. Spud Size and Location: NPS 1-1/2; top.
g. Color: White.

4. Support: Water-closet carrier.

2.4 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Solenoid Actuated: .

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

a. Delany Products.
b. Sloan Valve Company.
c. Zurn Industries, LLC.

2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Style: Exposed.
7. Exposed Flushometer-Valve Finish: Chrome-plated.
8. Panel Finish: Chrome-plated or stainless steel.
9. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.

11. Consumption: 1.28 gal. per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

2.5 TOILET SEATS

A. Toilet Seats: .

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

    a. American Standard.
    b. Church Seats; Bemis Manufacturing Company.
    c. Kohler Co.
    d. TOTO USA, INC.
    e. Zurn Industries, LLC.
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.6 SUPPORTS

A. Water-Closet Carrier:

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

    a. Jay R. Smith Mfg Co; a division of Morris Group International.
    b. MIFAB, Inc.
    c. Zurn Industries, LLC.
2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and

hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
5. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.

4. Install actuators in locations easily reachable for people with disabilities.
5. Install new batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.

3.3 PIPING CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224213.16 - COMMERCIAL URINALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall-hung urinals.
2. Urinal flushometer valves.
3. Supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

A. Urinals - Wall Hung, Back Outlet, Washout: Accessible.

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

   a. American Standard.
   b. Gerber Plumbing Fixtures LLC.
   c. Kohler Co.
   d. TOTO USA, INC.
   e. Zurn Industries, LLC.

2. Fixture:

   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
   b. Material: Vitreous china.
   c. Type: Washout with extended shields.
   d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
   e. Water Consumption: 0.125 gpf.
   f. Spud Size and Location: NPS 3/4, top.
   g. Outlet Size and Location: NPS 2, back.
   h. Color: White.

3. Waste Fitting:

   a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
   b. Size: NPS 2.

4. Support: Type I urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.2 URINAL FLUSHOMETER VALVES

A. Solenoid-Actuator, Diaphragm Flushometer Valves: .

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

   a. Sloan Valve Company.
   b. Stern Engineering Ltd.

c. Zurn Industries, LLC.

2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated metal.
7. Panel Finish: Chrome plated or stainless steel.
8. Style: Exposed.
9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
11. Consumption: 0.125 gal. per flush.
12. Minimum Inlet: NPS 3/4.
13. Minimum Outlet: NPS 3/4.

2.3 SUPPORTS

A. Type I Urinal Carrier:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. WATTS Water Technologies; A WATTS Company.
d. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.

B. Examine walls and floors for suitable conditions where urinals will be installed.

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

3.2 INSTALLATION

A. Urinal Installation:

1. Install urinals level and plumb according to rough-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install trap-seal liquid in waterless urinals.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.

3.3 PIPING CONNECTIONS

A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.

B. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed urinals and fittings.

C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vitreous-china, wall-mounted lavatories.
2. Automatically operated lavatory faucets.
3. Supply fittings.
4. Waste fittings.
5. Lavatory supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory - Vitreous China, Wall Mounted,:

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

   a. American Standard.
   b. Gerber Plumbing Fixtures LLC.
   c. Sloan Valve Company.
   d. Zurn Industries, LLC.

2. Fixture:

   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: Rectangular, 20 by 18 inches.
   d. Faucet-Hole Punching: Three holes, 2-inch centers.
   e. Faucet-Hole Location: Top.
   f. Color: White.
   g. Mounting Material: Chair carrier.

3. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Lavatory Faucets - Automatic Type: Battery Powered Electronic Sensor Operated, Mixing,:

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

   a. Chicago Faucets; Geberit Company.
   b. Kohler Co.

c. Krowne.
d. Moen Incorporated.
e. Zurn Industries, LLC.

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.

3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Three hole.
6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Aerator.
12. Provide thermostatic mixing valve conforming to ASSE 1070/ASME A112.1070

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.
b. Stainless steel, two-piece trap and swivel elbow with 0.012-inch thick stainless steel tube to wall, and stainless steel wall flange.

2.5 LAVATORY SUPPORTS

A. Lavatory Carrier:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. WATTS.
d. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

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. Service sinks.
2. Kitchen/utility sinks.
3. Handwash sinks.
4. Manually operated sink faucets.
5. Automatically operated sink faucets.
6. Supply fittings.
7. Waste fittings.
8. Sink supports.
9. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed but not less the 3.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed but not less than 3.

PART 2 - PRODUCTS

2.1 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted: .

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

a. Advance Tabco.
b. Elkay.
c. Just Manufacturing.

2. Source Limitations: Obtain sinks from single source from single manufacturer.

3. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back .
c. Material: 18 gauge, Type 304 stainless steel.
d. Compartment:

1) Drain: NPS 1-1/2 (DN 40) tailpiece with stopper.
2) Drain Location: Near back of compartment.

e. Each Compartment:

1) Drains: NPS 1-1/2 (DN 40) tailpiece with stopper.
2) Drain Location: Centered in compartment.

4. Faucet(s): Manually Operated Sink Faucet .
   a. Mounting: On ledge.

5. Supply Fittings:

   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

      1) Operation: Loose key.
      2) Risers: NPS 1/2 (DN 15), ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

6. Waste Fittings:

   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):

      1) Size: [**NPS 1-1/2 (DN 40)**] [**NPS 2 (DN 50)**].
      2) Material:

         a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

   c. Continuous Waste:

      1) Size: NPS 1-1/2 (DN 40).
      2) Material: Chrome-plated, 17-gauge brass tube.

7. Mounting: On counter with sealant.

B. Kitchen/Utility Sinks - Stainless Steel, Freestanding: .

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

   a. Advance Tabco.
   b. Elkay.
   c. Griffin Products, Inc.
   d. Just Manufacturing.

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

    a. Standards:

        1) ASME A112.19.3/CSA B45.4.
        2) NSF 2.

    b. Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
    c. Material: 14 gauge, Type 304 stainless steel.
    d. Compartment:

        1) Drain: Grid with NPS 2 (DN 50) tailpiece and twist drain.
        2) Drain Location: Centered in compartment.

    e. Each Compartment:

        1) Drains: Grid with NPS 2 (DN 50) tailpiece and twist drain.
        2) Drain Location: Centered in compartment.

    f. Integral Drainboard(s): Not required .

4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
5. Faucet(s): Manually Operated Sink Faucet .
    a. Mounting: On backsplash.

6. Supply Fittings:

    a. Standard: ASME A112.18.1/CSA B125.1.
    b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

        1) Operation: Loose key.
        2) Risers: NPS 1/2 (DN 15), ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

7. Waste Fittings:

    a. Standard: ASME A112.18.2/CSA B125.2.
    b. Trap(s):

        1) Size: NPS 2 (DN 50).
        2) Material:

a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

c. Continuous Waste:

1) Size: NPS 2 (DN 50).
2) Material: Chrome-plated, 17-gauge brass tube.

2.2 HANDWASH SINKS

A. Handwash Sinks - Stainless Steel: .

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

a. Advance Tabco.
b. Elkay.
c. Griffin Products, Inc.
d. Just Manufacturing.
e. Sloan Valve Company.

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

a. Standards:

1) ASME A112.19.3/CSA B45.4.
2) NSF 61.

b. Type: Wall-mounted stainless steel basin with radius corners, back for faucet, and support brackets.
c. Material: 16 gauge, Type 304 stainless steel.

4. Faucet: Automatically Operated Sink Faucet.
5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
7. Support: Type II sink carrier.
8. Mounting Height: Accessible in accordance with ICC A117.1.

2.3 MANUALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Manual Type: Two-handle mixing,.

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

    a. American Standard.
    b. Chicago Faucets; Geberit Company.
    c. Elkay.
    d. Just Manufacturing.
    e. Zurn Industries, LLC.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.

3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Centerset.
6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm (5.7 L/min).
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): 4-inch (102-mm) wrist blade.
11. Spout Type: Swivel gooseneck.
12. Spout Outlet: Aerator.

C. Commercial Service Sink Faucets - Manual Type: .

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

    a. Chicago Faucets; Geberit Company.
    b. Kohler Co.

c. Stern-Williams Co., Inc.
d. Zurn Industries, LLC.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.

3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch (20-mm) hose thread end, integral vacuum breaker, inlets 8 inches (200 mm) o.c., and two-handle mixing.
4. Faucet:

a. Standards:

1) ASME A112.18.1/CSA B125.1.
2) NSF 61 and NSF 372.
3) ICC A117.1.
4) ASSE 1001 (VB).

b. Finish: Polished chrome plated.
c. Handles: 4-inch (102-mm) wrist blade.
d. Cartridges: One-fourth turn compression.
e. Brace: Adjustable top brace.

2.4 AUTOMATICALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Automatic Type: Battery-powered, electronic-sensor-operated, mixing,.

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

a. Chicago Faucets; Geberit Company.
b. Just Manufacturing.
c. Kohler Co.
d. Zurn Industries, LLC.

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.

3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
4. 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.
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: Centerset.
7. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: Chrome plated.
9. Maximum Flow Rate: 0.5 gpm (1.9 L/min).
10. Mounting Type: Deck.
11. Spout Type: Rigid, gooseneck.
12. Spout Outlet: Aerator.
13. Thermostatic Mixing Valve: Below deck,, with check valves.

2.5 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Loose key.

F. Risers:

1. NPS 1/2 (DN 15).
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.6 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 (DN 40) offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 (DN 40).
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.7 SINK SUPPORTS

A. Sink Carrier:

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

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. Wade Drains.
d. Zurn Industries, LLC.

2. Source Limitations: Obtain sink supports from single source from single manufacturer.

3. Standard: ASME A112.6.1M.

2.8 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.
   1. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks.

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.5 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Eye/face wash equipment.
   2. Water-tempering equipment.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between 60 and 100 deg F (16 and 38 deg C).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:

   1. Plans, elevations, sections, mounting and attachment details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

A. Field Quality-Control Submittals:

1. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Units - Accessible, Wall Mounted, Plumbed: .

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

    a. Acorn Safety; a Division of Morris Group International.
    b. Bradley Corporation.
    c. Guardian Equipment Co.
    d. Stingray Systems LLC.

2. Source Limitations: Obtain eye/face wash units, accessible, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
4. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor: Chrome-plated brass or stainless steel bowl.
8. Mounting: Wall bracket.
9. Accessories:
    a. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
    b. Dust covers.

2.3 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water: .

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

    a. Acorn Safety; a Division of Morris Group International.
    b. Bradley Corporation.
    c. Guardian Equipment Co.
    d. Lawler Manufacturing Company, Inc.
    e. Leonard Valve Company.

2. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
3. Description: Factory-fabricated equipment with thermostatic mixing valve.

    a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.

b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATON OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals.

F. Install thermometers in supply and outlet piping connections to water-tempering equipment.

G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system.

H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system.

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping.

C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment.

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224500

SECTION 230500 - COMMON HVAC REQUIREMENTS

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 and all Division 23 Sections.

1.2 PLANS AND SPECIFICATIONS

A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.

B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.

C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term “Contractor” or “MC” appears, it shall imply the Contractor responsible for Division 23, Mechanical Work.

1.3 CONFLICTS

A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.

B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent and/or costly condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer. Under no circumstances will a change order be approved for work installed that was not approved by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.

B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.

C. Layouts of piping, ductwork, and equipment shown on drawings are diagrammatic. Contractor shall verify dimensions and layouts for specific project conditions, field verify any existing conditions, and coordinate with all other trades prior to procurement, fabrication and installation of equipment and material. Existing Conditions shall be field verified by contractor prior to bid submissions. Unknown conditions during construction due to omission of contractor field verification prior to bid shall be resolved by the contractor at no cost to the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

D. Make actual installations in accord with design layouts, but with necessary adjustments as determined by trade coordination, actual material and equipment procured, field verifications, and other project conditions in order to provide a fully functional and complete system, save and maintainable in all aspects. Any such required adjustments and deviations shall require specific approval of the Engineer/Architect prior to procurement, fabrication, and installation.

E. Take particular care to coordinate all piping, ductwork, and equipment under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner or project.

F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping, ducts and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.

G. The Owner or Owner's Representative reserves the right to relocate terminal equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no extra cost to the Owner or project.

1.5 REVIEW OF PROPOSED EQUIPMENT AND MATERIALS

A. Submittals:
   1. Contractor shall submit a complete list and schedule, including all proposed equipment and materials to the Construction Manager or Owner’s Representative and Engineer for review and approval within 10 business days of contract award..

2. Submit all proposed material, equipment, and fabrication shop drawings to the Engineer for approval prior to procurement, fabrication, and installation.

B. Substitution Requests:
1. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.
2. In addition to other contract provisions regarding substitution requests, , Contactor must certify by letter that he has checked the proposed substitution products or materials for conformance to applicable codes, standards, and regulations, specifications, and space limitations and assumes full responsibility thereafter.
3. Approval of substitution requests is at the sole discretion of the Engineer and Owner.
4. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
5. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner or Project, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

1.6 PERMITS, CODES AND ORDINANCES

A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.

B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

1.7 QUALITY ASSURANCE

A. Install HVAC Systems in accordance with applicable industry standards.

B. Install HVAC Systems in accordance with manufacturer's installation, operations and maintenance instructions.

1.8 COORDINATION WITH OTHER TRADES

A. Check mechanical drawings with all other trades including electrical, plumbing, fire protection and general construction.

B. Anticipate, avoid, and resolve interferences with other trades.

C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner. The use of coordination drawings is recommended but may not be required (refer to Division 1 for additional requirements). Lack of coordination drawings assumes contractor has verified and coordinated all work associated with installation.

D. Obtain decision for approval from project Engineer for proposed grouped installations before proceeding, and for clearance in structure and finish of the building.

E. Verify with drawings all ductwork and equipment layout in concealed areas.

F. The Contractor to coordinate with, receive and install, Owner furnished equipment where indicated.

G. Coordinate location of controls and instrumentation devices, including but not limited to control valves, control dampers, thermowells, pressure probes, flow switches, insertion flow meters, and ultrasonic flow meters, with Building Automation System (BAS) requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor and assume full responsibility for all materials while in storage with full visible identification and information.

1.10 PROJECT CONDITIONS

A. Existing Conditions: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of

field verification does not constitute a basis for change orders and additional costs incurred by the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

B. Existing facilities shall be considered occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.11 SUPPORTS

A. Mechanical Contractor is responsible for providing all support components necessary for properly supporting HVAC Systems including hangers, rods, anchors, steel, and bases.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 COMMON HVAC SYSTEMS INSTALLATION REQUIREMENTS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of HVAC systems.

B. Indicated locations and arrangements were used to size systems and address other design considerations. Install systems as indicated unless deviations to layout are approved by Architect and Engineer.

C. Install systems in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install systems indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.

F. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.

G. Diagonal runs of piping and ductwork are prohibited unless specifically indicated otherwise.

H. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.

I. Install systems and 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

J. Install equipment with all required manufacturer's service clearances maintained.

K. Install systems at indicated slopes.

L. Install systems free of sags and bends.

M. Install fittings for changes in direction and branch connections.

N. Install systems to allow application of insulation.

O. Select system components with pressure rating equal to or greater than system operating pressure.

P. Install escutcheons for penetrations of walls, ceilings, and floors.

Q. Running pipe and ductwork over electrical equipment and in elevator machine rooms is prohibited.

R. Running piping and ductwork into or through interior exit stairways, other than systems serving such stairwells as permitted by the International Building Code, is prohibited.

S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe and duct penetrations. Such Penetrations shall be sealed with firestop materials and required fire and smoke rated dampers shall be provided.

T. Install HVAC systems on required supports and bases meeting maximum allowable spans and sized for the specific loads.

U. Install controls and instrumentation devices for HVAC systems required for system operations and as indicated.

V. Install all roof mounted equipment, ductwork etc. in accordance with the Building Code of New York State Section 1609.

END OF SECTION 230500

SECTION 230502 – COMMON HVAC DEMOLITION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Description of Work: Provide removal systems as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

A. Existing HVAC systems, equipment and devices may not all be shown on the Drawings. Existing conditions, where indicated, are based on preliminary field observations and/or existing conditions documentation made available to the Architect and Engineer and must be verified. Report any discrepancies to the Architect and Engineer before disturbing the existing installation.

B. Prior to bidding, examine the site to determine all actual observable conditions. Additional work or scope changes due to the Contractor's failure to investigate such existing conditions shall not be grounds for change orders or cause additional costs to the owner and project.

1.3 COORDINATION

A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and HVAC Systems and services must remain in operation at all times, unless specifically approved otherwise.

B. Scheduling: Demolition work and any required shut-downs shall be scheduled in conjunction with all other trades and the owner. Contractor cooperation will be expected under all conditions.

C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Construction Manager or Owner's Representative and Owner.

D. Coordinate and ensure that all equipment affected by the work is de-energized and electrically disconnected by a qualified and authorized contractor or owner's representative prior to proceeding with demolition.

1.4 ADJACENT MATERIALS

A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.

B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Owner or Project.

1.5 TRANSIENT SERVICES

A. Locate and identify any and all services passing through the project area which serve areas outside the work limits.

B. Maintain all services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Architect and Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.

B. Items to be Salvaged: Verify with the Architect, Engineer, and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing materials and equipment at the project site.

3.2 DEMOLITION

A. General: Remove equipment, ductwork, piping, controls and related materials within the project work limits, as indicated.

B. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.

C. Patching: When materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

3.3 EXISTING SYSTEMS TO REMAIN

A. General: Protect and maintain access to existing systems which must remain. Reinstall existing systems disturbed.

B. Reconnections: Where systems in adjoining areas or indicated to remain, become disconnected or affected by demolition work, they shall be reconnected as required to restore original operation. Restoration work shall comply with requirements for new work.

3.4 EXISTING SYSTEMS WORK TO BE RELOCATED

A. General: Disconnect, remove, reinstall and reconnect equipment indicated to be relocated and where required to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions shall conform to requirements for new work.

3.5 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.

B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.

C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.6 CLEANING

Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 230502

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and electronically commutated direct current motors, installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Class B.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
5. Provide microfiber shaft grounding ring kits.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Motors shall be, variable-speed, DC, brushless motors, specifically designed for the voltage, frequency, and phase indicated.

B. Motors shall be complete with and operated by an integrated controller/inverter that operates the wound stator and senses rotor position to electronically commutate the stator.

C. Motors shall be designed for synchronous rotation.

D. Rotors shall be permanent magnet type with near zero rotor losses.

E. Motors shall have built-in soft start and soft speed change ramps.

F. Motors shall be able to be mounted with shaft in horizontal or vertical orientation.

G. Motors shall be permanently lubricated with ball bearings.

H. Motors shall maintain a minimum of 70% efficiency over the entire operating range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated orzinc coated, with plain ends and integral welded waterstop collar.

D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

B. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.

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

a. GE Construction Sealants; Momentive Performance Materials Inc.
b. Pecora Corporation.
c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
d. Sherwin-Williams Company (The).
e. The Dow Chemical Company.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings as new walls and slabs 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 or silicone sealant, seal space around outside of sleeve-seal fittings.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:

a. Piping Smaller Than NPS 6 : Cast-iron sleeves.
b. Piping NPS 6 and Larger: Sleeve-seal fittings.

2. Exterior Concrete Walls Below Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs Above Grade:

    a. Piping Smaller Than NPS 6: Steel pipe sleeves.
    b. Piping NPS 6 and Larger: Steel pipe sleeves.

5. Interior Partitions:

    a. Piping Smaller Than NPS 6: Steel pipe sleeves.
    b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Keeney Manufacturing Company (The).
4. Mid-America Fittings, Inc.
5. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.

f. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Duct-thermometer mounting brackets.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Sight flow indicators.
8. Flowmeters.
9. Thermal-energy meters.

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. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Weiss Instruments, Inc.
   b. Flo Fab, Inc.
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 blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Air-Duct Installation: With ventilated shroud.
   b. 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.

2.2 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. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in 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 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. WATTS
   b. Weiss Instruments, Inc.
   c. Flo Fab, Inc.
2. Standard: ASME B40.100.
3. Case: Liquid-filled, Solid-front, pressure relief type(s); cast aluminum or drawn steel; 6-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 or plastic.
10. Ring: Metal.
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 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.6 TEST PLUGS

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. WATTS
   2. Weiss Instruments, Inc.
   3. Flow Design, Inc.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F

F. Core Inserts: EPDM self-sealing rubber.

2.7 SIGHT FLOW INDICATORS

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. Ernst Flow Industries
   2. OPW Engineered Systems

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.8 FLOWMETERS

A. Venturi Flowmeters:

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. Nexus Valve, Inc.
   b. Preso Meters
   c. S.A. Armstrong Limited
2. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
3. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
4. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

   a. Design: Differential-pressure-type measurement for water.
   b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
   c. Minimum Pressure Rating: 250 psig.
   d. Minimum Temperature Rating: 250 deg F
   e. End Connections for NPS 2 and Smaller: Threaded.
   f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
   g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

5. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch- diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

   a. Scale: Gallons per minute.
   b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Conversion Chart: Flow rate data compatible with sensor.
8. Operating Instructions: Include complete instructions with each flowmeter.

2.9 THERMAL-ENERGY METERS

A. Ultrasonic, Thermal-Energy Meters:

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. Siemens Industry, Inc., Energy Management Division
   b. ONICON Incorporated
2. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
3. Flow Sensor: Transit-time ultrasonic type with transmitter.
4. Temperature Sensors: Insertion-type or strap-on transducer.
5. Indicator: Solid-state, integrating-type meter with integral battery pack.
   a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
   b. Battery Pack: Five-year lithium battery.
6. Accuracy: Plus or minus 1 percent.
7. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
8. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe 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 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 syphon fitting in piping for each pressure gage for steam.

L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install wafer-orifice flowmeter elements between pipe flanges.

Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

R. Install permanent indicators on walls or brackets in accessible and readable positions.

S. Install connection fittings in accessible locations for attachment to portable indicators.

T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

U. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

V. 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 space for service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter 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 inlet and outlet of each hydronic boiler shall be the following:
   1. Industrial-style, liquid-in-glass type.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:
   1. Industrial-style, liquid-in-glass type.

D. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be the following:
   1. Industrial-style, liquid-in-glass type.

E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

C. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

1. Liquid-filled, direct-mounted, metal case.

B. Pressure gages at suction and discharge of each pump shall be the following:

1. Liquid-filled, direct-mounted, metal case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 160 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Heating, Hot-Water Piping: Venturi type.

END OF SECTION 230519

SECTION 230523.12 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.1 for power piping valves.
7. ASME B31.9 for building services piping valves.

C. 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.

D. Refer to HVAC valve schedule articles for applications of valves.

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 handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

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

    a. Apollo Flow Controls; Conbraco Industries, Inc.
    b. Milwaukee Valve Company.
    c. NIBCO INC.
    d. WATTS.

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.
    h. Stem: Stainless steel.
    i. Ball: Stainless steel, vented.
    j. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or 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 or press-end option is indicated in valve schedules below.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece, with stainless-steel trim, full port, solder or press connection-joint ends.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port, solder or press connection-joint ends.

1. Valves may be provided with solder-joint ends instead of threaded ends.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port, solder or press connection-joint ends.

END OF SECTION 230523.12

SECTION 230523.13 - BUTTERFLY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Iron, single-flange butterfly valves.
2. Iron, grooved-end butterfly valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 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 B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.

G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

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. Milwaukee Valve Company.
    c. NIBCO INC.
    d. WATTS.

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. NPS 12 and Smaller CWP Rating: 200 psig.
    c. NPS 14 and Larger CWP Rating: 150 psig.
    d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    e. Body Material: ASTM A536, ductile iron.
    f. Seat: EPDM.
    g. Stem: One- or two-piece stainless steel.
    h. Disc: Aluminum bronze.

2.3 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 300 CWP:

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

    a. NIBCO INC.
    b. Shurjoint-Apollo Piping Products USA Inc.
    c. Victaulic Company.

2. Description:

    a. Standard: MSS SP-67, Type I.
    b. NPS 8 and Smaller CWP Rating: 300 psig.
    c. NPS 10 and Larger CWP Rating: 200 psig.
    d. Body Material: Coated, ductile iron.
    e. Stem: Two-piece stainless steel.
    f. Disc: Coated, ductile iron.
    g. Seal: EPDM.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine mating flange faces for damage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

D. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

END OF SECTION 230523.13

SECTION 230523.14 - CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Bronze swing check valves.
   2. Iron swing check valves.
   3. Iron swing check valves with closure control.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Block check valves in either closed or open position.

B. Use the following precautions during storage:

   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.1 for power piping valves.
6. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. NIBCO, Inc.
   b. WATTS
   c. Crane; a Crane brand
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.
f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

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. NIBCO, Inc.
   b. WATTS
   c. Crane; a Crane brand
2. Description:

   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. NIBCO, Inc.
2. Description:

   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A126, gray iron with bolted bonnet.
   e. Ends: Flanged.

f. Trim: Bronze.
g. Gasket: Asbestos free.
h. Closure Control: Factory-installed, exterior lever and spring.

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 check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 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 or iron, center-guided, metal-seat check valves.

B. If valves with specified SWP classes or CWP ratings are unavailable, 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.
2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

B. Pipe NPS 2-1/2 and Larger:

1. Iron swing check valves with metal seats, Class 125.

END OF SECTION 230523.14

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

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. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Equipment stands.
8. Equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated 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 PLASTIC PIPE HANGERS

A. Description: Similar to MSS SP-58, Types 1 through 58, factory-fabricated steel pipe hanger except hanger is made of plastic.

B. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

C. Flammability: ASTM D635, ASTM E84, and UL 94.

2.5 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

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

    a. ABB, Electrification Business.
    b. B-line; Eaton, Electrical Sector.
    c. Flex-Strut Inc.
    d. MIRO Industries.
    e. Unistrut; Atkore International.
    f. Wesanco, Inc.

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 galvanized steel.
8. Metallic Coating: Hot-dip galvanized.
9. Paint Coating: For Pools, epoxy, acrylic, or urethane, color selected by architect.

B. Non-MFMA Manufacturer Metal Framing Systems:

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

    a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
    b. CADDY; nVent.
    c. MIRO Industries.
    d. PHD Manufacturing, Inc.
    e. RectorSeal HVAC; a CSW Industrials Company.

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 galvanized steel.
8. Metallic Coating: Hot-dip galvanized.
9. Paint Coating: For pools, epoxy, acrylic, or urethane color selected by architect.

2.6 THERMAL-HANGER SHIELD INSERTS

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

1. Buckaroos, Inc.
2. CADDY; nVent.
3. National Pipe Hanger Corporation.
4. Pipe Shields Inc.
5. Piping Technology & Products, Inc.
6. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: 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. Simpson Strong-Tie Co., Inc.

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; Eaton, Electrical Sector.
b. Empire Tool and Manufacturing Co., Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated steel.
3. Outdoor Applications: Stainless steel.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. 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. 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 the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM 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 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.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.
e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation 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 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: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM 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 MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless steel pipe hangers and stainless steel or corrosion-resistant attachments for hostile environment applications such as crawlspaces, exterior, mechanical rooms and natatoriums.

G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. 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 might occur.
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 might occur.
19. 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 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 might occur 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 might be required in addition to expansion and contraction.

K. 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.

L. 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.

M. 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.

N. 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.

O. 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.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Valve tags.
7. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

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

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Craftmark Pipe Markers.

d. Marking Services, Inc.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of 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 of 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), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of 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 of 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-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.

B. Material: Vinyl.

C. Minimum Thickness: 0.005 inch.

D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.

E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.

F. Maximum Temperature: 160 deg F.

G. Minimum Width: 4 inches.

2.4 PIPE LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 DUCT LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.

B. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Letter and Background Color: As indicated for specific application under Part 3.

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 of 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. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1. Duct size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.6 VALVE TAGS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire or S-hook.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.

4. Marking Services Inc.

B. Description: Preprinted accident-prevention tags of plasticized card stock.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Sign and Label Colors:

1. White letters on an ANSI Z535.1 safety-blue background.

C. Locate equipment labels where accessible and visible.

D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in

accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.

B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.

C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:
1. Heating Water and Heating Glycol Piping: White letters on an ANSI Z535.1 safety-green background.
2. Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.
3. Potable and Other Water: White letters on an ANSI Z535.1 safety-green background.

3.6 INSTALLATION OF DUCT LABELS

A. Install self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

a. For air supply ducts: White letters on blue background.
b. For air return ducts: White letters on blue background**.**
c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.

B. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

3.7 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1. Valve-Tag Size and Shape:
   a. Refrigerant: 1-1/2 inches, round.
   b. Hot Water: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.8 INSTALLATION OF WARNING TAGS

A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.

B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
    a. Constant-volume air systems.
2. Balancing Hydronic Piping Systems:
    a. Variable-flow hydronic systems.
3. Balancing steam systems.
4. Testing, Adjusting, and Balancing Equipment:
    a. Heat exchangers.
    b. Motors.
    c. Condensing units.
    d. Heat-transfer coils.
5. Testing, adjusting, and balancing existing systems and equipment.
6. Sound tests.
7. Vibration tests.
8. Duct leakage tests.
9. Control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.4 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 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.

4. Dates of use.
5. Dates of calibration.

1.5 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 as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan 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 terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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 per 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 gage 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 according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by 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 not suitable 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 Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.

5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
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 starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.

d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring 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.

3.8 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 differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

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 exchanger 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 gage 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 until design water flow is achieved.

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 differential-pressure set point.
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 water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.

2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    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 exchanger 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 gage 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 until design water flow is achieved.

    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 differential-pressure set point.
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, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

3.9 PROCEDURES FOR HEAT EXCHANGERS

A. Adjust water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Measure inlet steam pressure.

D. Check settings and operation of safety and relief valves. Record settings.

3.10 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.

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.

5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.13 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Instrumentation:

1. Use portable, battery-operated, and microprocessor-controlled vibration meter with or without a built-in printer.
2. The meter shall automatically identify engineering units, filter bandwidth, amplitude, and frequency scale values.
3. The meter shall be able to measure machine vibration displacement in mils of deflection, velocity in inches per second, and acceleration in inches per second squared.
4. Verify calibration date is current for vibration meter before taking readings.

C. Test Procedures:

1. To ensure accurate readings, verify that accelerometer has a clean, flat surface and is mounted properly.
2. With the unit running, set up vibration meter in a safe, secure location. Connect transducer to meter with proper cables. Hold magnetic tip of transducer on top of the bearing, and measure unit in mils of deflection. Record measurement, then move transducer to the side of the bearing and record in mils of deflection. Record an axial reading in mils of deflection by holding nonmagnetic, pointed transducer tip on end of shaft.

3. Change vibration meter to velocity (inches per second) measurements. Repeat and record above measurements.
4. Record CPM or rpm.
5. Read each bearing on motor, fan, and pump as required. Track and record vibration levels from rotating component through casing to base.

D. Reporting:

1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.14 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.15 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.16 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.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. 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.

3.17 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.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.18 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.19 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 and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. 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 with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. 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. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex 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.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.

e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. 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 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.

K. 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.

L. 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.

M. 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 rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
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.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.20 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager or Owner’s Representative and the commissioning authority.

B. The Architect and/or the Commissioning authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.21 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.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:

a. One 10-foot section each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. One rectangular and round transition fitting.
e. Four support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields.

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.6 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials are to be applied.

B. Products do not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.

F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. Knauf Insulation.
    c. Manson Insulation Inc.
    d. Owens Corning.

G. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. Knauf Insulation.
    c. Manson Insulation Inc.
    d. Owens Corning.

H. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.

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.

2. Semirigid board material with factory-applied FSK jacket.

3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

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

    a. Armacell LLC.
    b. Nomaco.
    c. Sekisui Voltek, LLC.
    d. Thermaduct.

2.3 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Johns Manville; a Berkshire Hathaway company.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. 3M.
    b. Thermal Ceramics.
    c. Unifrax Corporation.

2.4 ADHESIVES

A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. Proto Corporation.
    c. Sekisui Voltek, LLC.
    d. Speedline Corporation.

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Knauf Insulation.
    d. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Knauf Insulation.
e. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.7 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand; H. B. Fuller Construction Products.

b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

2. Materials are 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.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

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. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.

2. Materials are 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.

2.8 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.

7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

    a. Johns Manville; a Berkshire Hathaway company.
    b. P.I.C. Plastics, Inc.
    c. Proto Corporation.
    d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier: 3-mil- thick polysurlyn.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Vimasco Corporation.

2.11 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Alpha Associates, Inc.

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

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

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.

c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

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 C1136.

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

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: 3 inches75 mm.
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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.

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. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 2 inches50 mm.
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.

2.13 SECUREMENTS

A. Bands:

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. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.

2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or larger diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

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

      1) AGM Industries, Inc.
      2) CL WARD & Family Inc.
      3) Gemco.

4) Midwest Fasteners, Inc.
5) Nelson Stud Welding.

2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

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

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

3. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Gemco.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

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

a. C & F Wire.
b. Johns Manville; a Berkshire Hathaway company.

c. RPR Products, Inc.

2.14 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.

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. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.

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, but not to the extent of creating wrinkles or areas of compression in the insulation.
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.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

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.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC AND POLYOLEFIN INSULATION

A. Comply with manufacturer's written installation instructions and ASTM C1710.

B. 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.

C. Square and Rectangular Ducts and Plenums:

1. Provide 1/4 inch more per side for a tight, compression fit.
2. Cut sheet insulation with the following dimensions:

a. Width of duct plus 1/4 inch, one piece.
b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.

3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
4. Insulation without self-adhering backing:

a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
b. Roll sheet down into position.
c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.

5. Insulation with self-adhering backing:

a. Peel back release paper in 6- to 8-inch increments and line up sheet.
b. Press firmly to activate adhesive.
c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.
d. Allow 1/4-inch overlap for compression at butt joints.

e. Apply adhesive at the butt joint to seal the two sheets together.

6. Insulate duct brackets following manufacturer's written installation instructions.

D. Circular Ducts:

1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
2. Cut the sheet to the required size.
3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

B. Comply with manufacturer's written installation instructions.

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 overcompress 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 consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. 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 overcompress 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 consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

   1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

   1. Draw jacket material smooth and tight.

2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Comply with manufacturer's written installation instructions.

B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

C. Insulate duct access panels and doors to achieve same fire rating as duct.

D. Install firestopping at penetrations through fire-rated assemblies.

3.9 DUCT AND PLENUM INSULATION SCHEDULE

A. Interior supply air ductwork.

1. Concealed Locations: Mineral-Fiber Blanket; R-6.
2. Exposed Locations: Mineral-Fiber Board; R-6.
3. Exception: Supply air ductwork exposed to view in conditioned spaces served by ductwork shall not be insulated.

B. Interior outdoor air ductwork and plenums.

1. Concealed Locations: Mineral-Fiber Blanket; R-12
2. Exposed Locations: Mineral-Fiber Board; R-12

C. Interior exhaust air ductwork and plenums (3 feet from penetration of building exterior or isolation damper, whichever is longer).

1. Concealed Locations: Mineral-Fiber Blanket; R-12
2. Exposed Locations: Mineral-Fiber Board; R-12

D. Attic supply air, return air, outdoor air, and exhaust air ductwork.

1. Mineral-Fiber Board; R-12

E. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

F. Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

3.10 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed,:

1. Painted Aluminum, Stucco Embossed: 0.024 inch thick.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulation for HVAC piping systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

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

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot section of NPS 2 straight pipe.
b. One each of a 90 degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, press, and flanged tee fitting.
d. One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.
e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.
k. One control valve.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and

"Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

1. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

a. Johns Manville; a Berkshire Hathaway company.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.

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

a. Aeroflex USA.
b. Airex Manufacturing.
c. Armacell LLC.
d. K-Flex USA.

H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

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.

2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.

3. 850 deg F.
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

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. Ramco Insulation, Inc.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

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. Ramco Insulation, Inc.

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: Solvent-based adhesive.

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

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F.
4. Service Temperature Range: 40 to 200 deg F.
5. Color: Black.

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. ASJ Adhesive and FSK and PVDC 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.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

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. The Dow Chemical Company.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

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

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Knauf Insulation.
    d. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

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. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

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. Vimasco Corporation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.

2. Permanently flexible, elastomeric sealant.
a. Service Temperature Range: Minus 150 to plus 250 deg F.
b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

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

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

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. Childers Brand; H. B. Fuller Construction Products.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

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

   a. Johns Manville; a Berkshire Hathaway company.
   b. P.I.C. Plastics, Inc.
   c. Proto Corporation.
   d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

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. Polyguard Products, Inc.

F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Polyguard Products, Inc.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

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

    a. 3M Industrial Adhesives and Tapes Division.
    b. Avery Dennison Corporation, Specialty Tapes Division.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

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 C1136.

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

    a. 3M Industrial Adhesives and Tapes Division.
    b. Avery Dennison Corporation, Specialty Tapes Division.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. 3M Industrial Adhesives and Tapes Division.
   b. Ideal Tape Co., Inc., an American Biltrite Company.

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. 3M Industrial Adhesives and Tapes Division.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

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. Bands:

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. RPR Products, Inc.

2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

3. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, galvanized steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, 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 storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
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, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 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 in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece 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 of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at all serviceable locations such as unions, gauges, petes plugs control valves, strainers, and equipment connections. 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 that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install 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 that of 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.

3.7 INSTALLATION OF MINERAL-FIBER 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 that of 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 that of 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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated and for horizontal applications, 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.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating on exterior insulation.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. 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.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu • in./(h • ft^2 • °F)[b]	Mean Rating Temperature, °F	< 1	1 to < 1$^1/_2$	1$^1/_2$ to < 4	4 to < 8	≥ 8
> 350	0.32 - 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5
40 – 60	0.21 – 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 – 0.26	50	0.5	1.0	1.0	1.0	1.5

A. Condensate and Equipment Drain Water:

   a. Cellular Glass
   b. Flexible Elastomeric
   c. Phenolic

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

   a. Cellular Glass

C. Refrigerant Suction and Hot-Gas Piping:
   a. Flexible Elastomeric
   b. Phenolic

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

   a. Flexible Elastomeric
   b. Polyolefin

E. Refrigerant Liquid Piping:
   a. Flexible Elastomeric
   b. Phenolic

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:
1. PVC: 30 mils thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping:
1. Painted Aluminum, Stucco Embossed: 0.020 inch thick.

3.14 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.

B. This section defines the commissioning responsibilities of the Division 23 Contractor (referred to herein as either "MC" or "the Contractor") and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.

C. The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.

D. Related Requirements:
1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.

E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
1. A/E: Architects and Engineers
2. Cx: Commissioning
3. CxA: Commissioning Authority
4. Cx Plan: Commissioning Plan Document
5. CC: Controls Contractor
6. CM: Construction Manager
7. EC: Electrical Contractor
8. FT: Functional Performance Test
9. MC: Mechanical Contractor
10. PFI: Pre-Functional Inspection
11. TAB: Test and Balance Contractor

1.2 INFORMATIONAL SUBMITTALS

A. Prefunctional Checklists
1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

B. Startup and Manufacturer Test Reports
1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.

C. Requests for Clarification

1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the MC shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MEETINGS

A. Attend commissioning meetings as described in the General Commissioning Requirements.

B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the CM and CxA.

3.2 COORDINATION AND SCHEDULING

A. MC shall coordinate schedule for prefunctional checklists and equipment startup with CxA.

B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

3.3 PREFUNCTIONAL CHECKLISTS

A. Blank copies of the required checklists will be provided by the CxA for use by the MC.

B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the EC on equipment provided by the MC) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.

D. The MC shall submit any requests for direction on completion of checklists in writing to the CM and CxA.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented

design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.

B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.

C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).

D. MC shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.

E. General testing requirements:
1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

3.5 SEASONAL TESTING

A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the MC shall provide qualified personnel to assist with execution of tests. Where required, the MC shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

3.6 MANUFACTURER'S FIELD SERVICE

A. Where required in these specifications, the MC shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").

B. The MC shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and

schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.

C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.

D. Following correction of deficiencies, the MC shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

A. MC shall be responsible for responding to deficiencies or items of non-conformance related to the system.

B. Where deficiencies are identified during the commissioning process, the MC shall issue a written response.

C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.

D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.

E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

3.8 OWNER TRAINING

A. Training shall be provided by the MC in coordination with the Owner, CM and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

3.9 PERSONNEL

A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION 230800

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Plastic pipe and fittings.
4. Joining materials.
5. Transition fittings.
6. Dielectric fittings.

1.2 ACTION SUBMITTALS

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

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 100 psig at 200 deg F.
2. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
3. Makeup-Water Piping: 150 psig at 150 deg F.
4. Condensate-Drain Piping: 180 deg F.
5. Blowdown-Drain Piping: 200 deg F.
6. Air-Vent Piping: 200 deg F.
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type L.

B. DWV Copper Tube: ASTM B306, Type DWV.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Wrought Copper Unions: ASME B16.22.

F. Grooved, Mechanical-Joint, Copper Tube Appurtenances:

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

   a. Anvil International.
   b. Victaulic Company.

2. Grooved-End Copper Fittings: ASTM B75, copper tube or ASTM B584, bronze castings.
3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum 230 deg F for use with ferrous housing, and steel bolts and nuts; 300 psigminimum CWP pressure rating.

G. Copper-Tube, Pressure-Seal-Joint Fittings:

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

   a. Elkhart Products Corporation.
   b. NIBCO INC.
   c. Viega LLC.

2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "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 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A234/A234M, wall thickness to match adjoining pipe.

G. 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.

H. Grooved Mechanical-Joint Fittings and Couplings:

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

   a. Anvil International.
   b. Gustin Bacon Company.
   c. Victaulic Company.

2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, 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 EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Plain-End Mechanical-Joint Couplings:

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

   a. Anvil International.
   b. Shurjoint-Apollo Piping Products USA Inc.
   c. Victaulic Company.

2. Housing: ASTM A536 Grade 65-45-12 segmented ductile iron or type 304 stainless steel.
3. Housing coating: None.
4. Gasket: EPDM.

5. Sealing Mechanism: Double-lip sealing system or carbon steel case-hardened jaws.
6. Bolts, hex nuts, washers, or lock bars based on manufacturer's design.
7. Minimum Pressure Rating: Equal to that of the joined pipes.

J. Steel Pressure-Seal Fittings:

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. Victaulic Company.
   b. Viega LLC.

2. Housing: Steel.
3. O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum 300-psig working-pressure rating at 230 deg F.

K. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.

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

   a. Charlotte Pipe and Foundry Company.
   b. IPEX USA LLC.
   c. Spears Manufacturing Company.

2. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

2.5 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 otherwise 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 B32, lead-free alloys. Include water-flushable flux according to ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, 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 D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

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

a. Charlotte Pipe and Foundry Company.
b. IPEX USA LLC.
c. Uponor.
d. Viega LLC.

2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

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

a. Charlotte Pipe and Foundry Company.
b. IPEX USA LLC.
c. NIBCO INC.
d. Spears Manufacturing Company.

2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

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

a. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. HART Industrial Unions, LLC.
d. Jomar Valve.
e. Zurn Industries, LLC.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 125 psig minimum at 180 deg F.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Company.
b. Matco-Norca.
c. Zurn Industries, LLC.

2. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.
c. Pressure Rating: 125 psig minimum at 180 deg F.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

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. Calpico, Inc.
c. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

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

a. Elster Perfection Corporation.
b. Precision Plumbing Products.
c. Victaulic Company.

2. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F1545.
c. Pressure Rating: 300 psig at 225 deg F.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.8 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Piping, aboveground, NPS 2.5 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.

B. Piping, aboveground, NPS 3 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and grooved joints.
2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Condensate-Drain Piping, Copper: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints in plenums and Schedule 40 PVC plastic pipe and fittings and solvent-welded joints in all other locations.

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 piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

F. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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 unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.

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 D10.12M/D10.12, using qualified processes and welding operators according to "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.

G. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

H. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tools and procedure, and brazed joints.

J. Pressure-Sealed Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

B. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support vertical runs of PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 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 gauges and thermometers at coil inlet and outlet connections.

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: 9.0 to 10.5.
2. "P" Alkalinity: 100 to 500 ppm.

3. Boron: 100 to 200 ppm.
4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
5. Corrosion Inhibitor:

    a. Sodium Nitrate: 1000 to 1500 ppm.
    b. Molybdate: 200 to 300 ppm.
    c. Chromate: 200 to 300 ppm.
    d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
    e. Chromate Plus Molybdate: 50 to 100 ppm each.

6. Soluble Copper: Maximum of 0.20 ppm.
7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
8. Total Suspended Solids: Maximum of 10 ppm.
9. Ammonia: Maximum of 20 ppm.
10. Free Caustic Alkalinity: Maximum of 20 ppm.
11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
    b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
    c. Nitrate Reducers: 100 organisms/mL.
    d. Sulfate Reducers: Maximum of zero organisms/mL.
    e. Iron Bacteria: Maximum of zero organisms/mL.

B. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

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 the "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 boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

1.2 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.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

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, provide products by one of the following:

    a. Bell & Gossett; a Xylem brand.
    b. NIBCO INC.
    c. TACO Comfort Solutions, Inc.
    d. Victaulic Company.

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, provide products by one of the following:

    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
    e. Victaulic Company.
    f. WATTS.

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: Stainless Steel, 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, provide products by one of the following:

    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
    e. WATTS.

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: Stainless Steel, 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.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

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

    a. AMTROL, Inc.
    b. Apollo Flow Controls; Conbraco Industries, Inc.
    c. Armstrong Pumps, Inc.
    d. Bell & Gossett; a Xylem brand.
    e. TACO Comfort Solutions, Inc.

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. Automatic Air Vents:

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

   a. AMTROL, Inc.
   b. Bell & Gossett; a Xylem brand.
   c. Spirotherm, Inc.
   d. TACO Comfort Solutions, Inc.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

2.3 STRAINERS

A. Y-Pattern Strainers:

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

   a. Keckley Company.
   b. Metraflex Company (The).
   c. Titan Flow Control, Inc.
   d. WATTS.

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, 40-mesh strainer, or perforated stainless-steel basket.
5. CWP Rating: 125 psig.

B. Basket Strainers:

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

   a. Keckley Company.
   b. Metraflex Company (The).
   c. Titan Flow Control, Inc.
   d. WATTS.

2. Body: ASTM A126, Class B, high-tensile 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: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
5. CWP Rating: 125 psig.

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

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.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of 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 check valves at each pump discharge and elsewhere as required to control flow direction

C. 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.

D. 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 automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, vertically mounted, in-line centrifugal pumps.

1.2 DEFINITIONS

A. ECM: Electronically commutated motor.

B. EPDM: Ethylene propylene diene monomer.

C. EPR: Ethylene propylene rubber.

D. FKM: Fluoroelastomer polymer.

E. HI: Hydraulic Institute.

F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump.

1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
2. Indicate pump's operating point on curves.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One (1) mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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. Bell & Gossett; a Xylem brand
2. Grundfos Pumps Corporation
3. TACO Comfort Solutions, Inc.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. 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.

D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.

2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft Sleeve: Type 304 stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM rubber bellows and gasket. Include water slinger on shaft between motor and seal.
5. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.

E. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure : Open drip proof.
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Variable-speed motor.
6. Provide integral pump motor variable-speed controller.

2.3 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

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. Bell & Gossett; a Xylem brand
2. TACO Comfort Solutions, Inc.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately 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 vertically.

D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet**,** replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Carbon steel, Type 304 stainless steel shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket.

E. Shaft Coupling: Interlocking frame with interconnecting springs capable of absorbing vibration.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure: Open drip proof
2. NEMA Premium Efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Variable-speed motor.
6. Provide integral pump motor variable-speed controller.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
4. Carbon steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

2.5 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.

1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet MS/TP.
3. Commissioning and pump set up access to pump controls via the following:

    a. A web interface (data exchange).
    b. A user interface located on the face of speed controller to adjust modes and mode values.
    c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.

4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control (delta-p/c), variable differential pressure control (delta-p/v), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:

    a. Manual (via user interface or HTML).
    b. Remote via 0 to 10 V dc.
    c. Data protocol communications with the BMS.

5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.
7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
8. Pump capable of being monitored continuously via integrated Internet link.

2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)

A. Provide pumps so they are specified or scheduled with ECM.

1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.

4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps will be installed.

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

3.2 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.3 PIPING CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install triple-duty valve on discharge side of pumps.

E. Install suction diffuser and shutoff valve on suction side of pumps.

1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.

H. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.4 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

2. Check piping connections for tightness.
3. Clean strainers on suction piping. Use startup strainer for initial startup.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.7 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Hydronic pumps will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Thermostatic expansion valves.
b. Solenoid valves.
c. Hot-gas bypass valves.
d. Filter dryers.
e. Strainers.
f. Pressure-regulating valves.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:

1. Suction Lines for Air-Conditioning Applications: 115 psig.
2. Suction Lines for Heat-Pump Applications: 225 psig.
3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L ASTM B 280, Type ACR.

B. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8/A5.8M.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

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

a. Danfoss Inc.
b. Henry Technologies Inc.; The Henry Group.
c. Parker Hannifin Corp.
d. Paul Mueller Company.

2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.

6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

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

    a. Danfoss Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker Hannifin Corp.
    d. Paul Mueller Company.
    e.

2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

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

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Danfoss Inc.
    c. Emerson Climate Technologies; Emerson Electric Co.
    d. Parker Hannifin Corp.
    e. Paul Mueller Company.

2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.
6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

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

    a. Danfoss Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Parker Hannifin Corp.
    d. Paul Mueller Company.
    e. RectorSeal HVAC; a CSW Industrials Company.

2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

E. Refrigerant Locking Caps:

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

    a. C & D Valve, LLC.
    b. JB Industries.
    c. RectorSeal HVAC; a CSW Industrials Company.

2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant charging ports from unauthorized refrigerant access and leakage.
3. Material: Brass, with protective shroud or sleeve.
4. Refrigerant Identification: Color-coded, refrigerant specific or Universal design.
5. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

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

    a. Danfoss Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Parker Hannifin Corp.
    e. Paul Mueller Company.

2. Body and Bonnet: Plated steel.
3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and ac coil.
7. Working Pressure Rating: 400 psig.
8. Maximum Operating Temperature: 240 deg F.

G. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.

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

    a. Danfoss Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker Hannifin Corp.
    d. Paul Mueller Company.

2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
3. Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Threaded.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

H. Thermostatic Expansion Valves: Comply with AHRI 750.

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

    a. Danfoss Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Paul Mueller Company.

2. Body, Bonnet, and Seal Cap: Forged brass or steel.

3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
6. Suction Temperature: 40 deg F.
7. Superheat: Adjustable.

8. Reverse-flow option (for heat-pump applications).
9. End Connections: Socket, flare, or threaded union.
10. Working Pressure Rating: 700 psig.

I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.

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

    a. Danfoss Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker Hannifin Corp.

2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
4. Packing and Gaskets: Non-asbestos.
5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
6. Seat: Polytetrafluoroethylene.
7. Equalizer: Internal or External.
8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit.
9. End Connections: Socket.
10. Throttling Range: Maximum 5 psig.
11. Working Pressure Rating: 500 psig.
12. Maximum Operating Temperature: 240 deg F.

J. Straight-Type Strainers:

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

    a. Danfoss Inc.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker Hannifin Corp.

2. Body: Welded steel with corrosion-resistant coating.
3. Screen: 100-mesh stainless steel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Angle-Type Strainers:

    a. Danfoss, Inc.

b. Henry Technologies Inc.; The Henry Group.
c. Parker Hannifin Corporation.

2. Body: Forged brass or cast bronze.

3. Drain Plug: Brass hex plug.
4. Screen: 100-mesh monel.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

L. Moisture/Liquid Indicators:

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

a. Danfoss Inc.
b. Emerson Climate Technologies; Emerson Electric Co.
c. Henry Technologies Inc.; The Henry Group.
d. Parker Hannifin Corp.

2. Body: Forged brass.

3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
4. Indicator: Color coded to show moisture content in parts per million (ppm).
5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
6. End Connections: Socket or flare.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 240 deg F.

M. Replaceable-Core Filter Dryers: Comply with AHRI 730.

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

a. Danfoss Inc.
b. Emerson Climate Technologies; Emerson Electric Co.
c. Henry Technologies Inc.; The Henry Group.
d. Parker Hannifin Corp.

2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.

3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.

4. Desiccant Media: Activated charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730.

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

    a. Danfoss Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.
    d. Parker Hannifin Corp.

2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

O. Mufflers:

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

    a. Danfoss Inc.
    b. Emerson Climate Technologies; Emerson Electric Co.
    c. Henry Technologies Inc.; The Henry Group.

2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

P. Receivers: Comply with AHRI 495.

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. Henry Technologies Inc.; The Henry Group.
2. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

Q. Liquid Accumulators: Comply with AHRI 495.

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

    a. Emerson Climate Technologies; Emerson Electric Co.
    b. Henry Technologies Inc.; The Henry Group.
    c. Parker Hannifin Corp.

2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

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

    a. Arkema Inc.
    b. DuPont Fluorochemicals Div.
    c. Genetron Refrigerants; Honeywell International Inc.
    d. Mexichem Fluor Inc.

B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

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

    a. Arkema Inc.
    b. DuPont Fluorochemicals Div.
    c. Genetron Refrigerants; Honeywell International Inc.
    d. Mexichem Fluor Inc.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

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

    a. Arkema Inc.
    b. DuPont Fluorochemicals Div.
    c. Genetron Refrigerants; Honeywell International Inc.
    d. Mexichem Fluor Inc.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:

1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping:

1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.4 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-size, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.

2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.

3.5 INSTALLATION OF PIPING, GENERAL

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. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. 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 if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

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. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.

2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors.

T. Install sleeve seals for piping penetrations of concrete walls and slabs.

U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.6 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. 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.

F. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

I. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. 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.

B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting.

D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. 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.

B. Prepare test and inspection reports.

3.9 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.

3.10 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 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.

1. Cleaning compounds.
2. Chemical treatment for closed loop hydronic systems.
3. Water treatment equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Minimize corrosion, scale buildup, and biological growth for optimum efficiency of mechanical equipment without creating a hazard to operating personnel or the environment.

B. Base water treatment program 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. Chemically treat and maintain closed-loop hydronic system water to meet following standards:

1. Suspended solids: None.
2. Iron Corrosion Rate: stable rate, 0.5 mils per year maximum, no pitting.
3. Copper Corrosion Rate: stable rate, 0.2 mils per year maximum, no pitting.
4. Total Iron Concentration: 0.5 mg/L Fe maximum.
5. Total Copper Concentration: 0.2 mg/L Cu maximum.
6. pH: 8.5 – 9.5, accuracy ±0.1
7. Conductivity <2500 µS/cm (micro siemens/cm)
8. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
9. Boron: Maintain a value within 100 to 200 ppm.
10. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
11. TDS: Maintain a maximum value of 10 ppm.

12. 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.

1.3 ACTION SUBMITTALS

A. Product data for each type of chemical supplied. Include manufacturer's technical product data, material safety data sheets and manufacturer’s instructions for proper application of chemicals.
    1. Bypass feeders.
    2. Water meters.
    3. Inhibitor injection timers.
    4. pH controllers.
    5. Chemical solution tanks.
    6. Injection pumps.
    7. Chemical-treatment test equipment.
    8. Chemical material safety data sheets.
    9. Inhibited propylene glycol.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.
    1. Include plans, elevations, sections, and attachment details.
    2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.

C. Water Analysis: Illustrate water quality available at Project site.

D. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operations and Maintenance Manual: Include the following:

1. Material Safety Data Sheets for chemical supplied.
2. Manufacturer's instructions for proper application of chemicals.
3. Maintenance schedules for application and testing.
4. System volume(s).
5. Water Analysis Report
6. Operations and Maintenance Manuals for equipment and systems

1.6 QUALITY ASSURANCE

A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Architect, and Owner about water treatment.

B. Chemical Standards: Meet state and local environmental regulations.

1.7 QUALIFICATIONS

A. Water treatment company specializing in performing the work specified in this Section with minimum five years experience. Company shall be capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 REGULATORY REQUIREMENTS

A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and to public sewage systems.

1.9 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions for a period of one year from date of Substantial Completion.

1. Provide technical service visits to perform field inspections and make water analysis on site six months and eleven months after completion. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
2. Provide laboratory and technical assistance services during this maintenance period.
3. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.
4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

PART 2 - PRODUCTS

2.1 CLEANING CHEMICALS

A. Cleaning Solution: neutral pH cleaning solution which is capable of removing oil, grease, and rust from metal surfaces of system and passivating cleaned metal surfaces of system. Cleaning solution shall include:

1. Low foaming non-ionic surfactant for penetrating oily and greasy deposit surfaces.
2. Solvent for dissolving oil and grease.
3. Dispersant for dissolving rust.
4. Reducing agent for corrosion control.
5. Ferrous and non-ferrous metal corrosion inhibitors.

B. All chemicals to be acceptable for discharge to sanitary sewer.

2.2 TREATMENT CHEMICALS

A. Furnish chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality. Provide only chemicals that are compatible with piping materials, seals, and accessories.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: 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: 2 gal.
2. Minimum Working Pressure: 175 psig.

B. Provide test kits for all treatment programs.

2.4 AUTOMATIC GLYCOL FEEDER

A. Manufacturer: subject to compliance with requirements, provide products by one of the following:

1. Wessels Company
2. Neptune
3. J.L. Wingert Co.

B. General: provide and install a completely pre-fabricated/preassembled package glycol feeder system with: single point power connection, injection pump, fluid holding tank, interconnecting piping and wiring, and control panel.

C. Pump

1. Material: Bronze
2. Fluid flow rate: per scheduled data
3. Discharge pressure: per scheduled data

D. Tank: shall be constructed of polyethylene with a four-leg steel stand with attachment bolts at each leg. Tank shall have upper and lower steel support banding. Steel support stand to be painted with corrosion resistant enamel.

E. Piping

1. Piping to be rated for system pressure and use within a pressurized system.
2. Pump suction piping: to be constructed of PVC tubing and fittings. PVC shutoff valve and strainer to be furnished.
3. Pump discharge piping: constructed of schedule 40 brass and brass fittings. Discharge to come equipped with pressure switch, pressure gage, isolation valve, check valve, and relief valve. Relief valve to be piped back to the holding tank.

F. Control Panel

1. 115 volt, single phase power connection
2. NEMA 4X enclosure
3. HOA switch with running light and starter.

G. Level switch: low level switch shall engage a low level alarm. Alarm shall be issued to the central BAS system as well as a local, audible, alarm.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

1. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
2. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
3. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded body design with adjustable stem packing, threaded ends, and 250-psig SWP and 600-psig CWP ratings.

2.6 CHEMICAL TREATMENT TEST EQUIPMENT

A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.

1. Provide test kits for all treatment programs.

B. Corrosion Test-Coupon Assembly: Two station rack 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.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article. Submit analysis report to owner for review and include in Operations and Maintenance Manual submission.

3.2 INSTALLATION

A. Install treatment equipment level and plumb, in accordance with manufacturer's instructions.

B. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

C. Provide 3/4 inch water coupon rack around circulating pumps. Maintain access to coupon rack.

D. Install piping adjacent to equipment to allow service and maintenance.

3.3 CLEANING - GENERAL

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning.

C. Manual and automatic valves are in full open position.

D. By-pass valves are operated to ensure full flow through entire system.

E. Safety devices, including pressure relief valves, flow switches, and pressure switches are functioning.

F. Temporary fine mesh strainers for system pump and control valve strainer baskets are installed and cleaned as required.

3.4 CLEANING PROCEDURE

A. Step 1: Fill system with domestic water, establish circulation, and heat system contents to a temperature of 140°F.

B. Step 2: After two hours of circulation, collect water samples from at least three different locations in system. If these samples contain suspended solids, clean out strainer baskets, drain system, and repeat steps 1 & 2.

C. Step 3: Blend in prepared concentrated cleaning solution, establish circulation, and maintain system temperature at 140°F for at least three days.

D. Step 4: Dump spent cleaning solution to disposal, fill system with domestic water, circulate system contents for at least two hours, and dump spent rinse water to disposal.

E. Step 5: Fill system with domestic water and repeat step 4 until water samples collected from system are free of oil, grease, and suspended solids.

F. Step 6: Drain system completely, including all system low points and perform visual inspections of metal surfaces at three different locations.

G. Complete steps 4, 5 & 6 within a 24 hour period.

H. If metal surfaces contain oil/grease or silt, fill the system with domestic water and repeat steps 3, 4, 5 & 6.

I. Immediately after inspection is completed, install strainers, fill system with glycol solution, blend in concentrated corrosion inhibitor solution until its concentration in system is at an acceptable level for film formation, and pass system water through corrosion coupon rack.

3.5 ADJUSTING

A. Sample water at two-week intervals after each system startup for a period of three months, and prepare certified test report for each required water performance characteristic. Where applicable, comply with industry standard test procedures.

3.6 DEMONSTRATION

A. Provide services of water treatment firm’s representative for half a day to instruct Owner's personnel in operation, maintenance, and testing procedures of chemical water treatment system.

B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.

1. Review manufacturer's safety data sheets for handling of chemicals.

2. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 01 Section Closeout Procedures.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round ducts and fittings.
4. Double-wall round ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to ASCE/SEI 7.

D. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

G. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with 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."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with 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 in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 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."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Source Limitations: Obtain double-wall rectangular ducts and fittings from single manufacturer.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for clear internal dimensions of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
   1. For ducts exposed to weather, construct outer duct of aluminum indicated by manufacturer to be suitable for outdoor installation.

D. Transverse Joints: Select joint types and fabricate in accordance with 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."

   1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
   2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
   3. Provide weather tight clips at all joints.

E. Longitudinal Seams: Select seam types and fabricate in accordance with 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." Provide weather tight clips at all joints.

F. Inner Duct: Solid galvanized sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

G. Interstitial Insulation, 2″ Foam complying with NFPA 90A, or NFPA 90B.

   1. R-12 insulation.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.
   4. Cover insulation with polyester film complying with UL 181, Class 1.

2.4 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of stainless steel indicated by manufacturer to be suitable for outdoor installation.

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

    a. Linx Industries; a DMI company (formerly Lindab).
    b. MKT Metal Manufacturing.
    c. SEMCO, LLC; part of FlaktGroup.
    d. Sheet Metal Connectors, Inc.
    e. Spiral Manufacturing Co., Inc.

B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.

C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

D. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

E. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate in accordance with 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."

2.5 DOUBLE-WALL ROUND DUCTS AND FITTINGS

A. Source Limitations: Obtain double-wall round ducts and fittings from single manufacturer.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   1. For ducts exposed to weather, construct outer duct of aluminum indicated by manufacturer to be suitable for outdoor installation.
   2. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

      a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
      b. Provide weather tight clips at all joints.

   3. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

      a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
      b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
      c. Provide weather tight clips at all joints.

   4. Tees and Laterals: Select types and fabricate in accordance with 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."

D. Inner Duct: Solid galvanized sheet steel. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

A. Interstitial Insulation, 2" Foam complying with NFPA 90A, or NFPA 90B.

1. R-12 insulation.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1

2.6 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 are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
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.

2.7 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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. Owens Corning.

2. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
3. Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
5. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

C. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.

7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless Steel Ducts: Stainless steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. 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.

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

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 arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR TYPE 1 COMMERCIAL KITCHEN GREASE HOOD EXHAUST DUCT

A. Install ducts in accordance with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operation"; SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; and SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines" unless otherwise indicated.

B. Install all ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

C. All ducts exposed to view are to be constructed of stainless steel as per "Duct Schedule" Article. All ducts concealed from view are to be [stainless] [**carbon**] steel as per "Duct Schedule" Article.

D. All joints are to be welded and are to be telescoping, bell, or flange joint as per NFPA 96.

E. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of [**20**] [12] <**Insert dimension**> feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings.

F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR EXHAUST DUCTS SERVING COMMERCIAL DISHWASHERS AND OTHER HIGH-HUMIDITY LOCATIONS

A. Install dishwasher exhaust ducts and other exhaust ducts from wet, high-humidity locations without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to dishwasher or toward drain.

B. Provide a drain pocket at each low point and at the base of each riser with a 1-inch trapped copper drain from each drain pocket to open site floor drain.

C. Minimize number of transverse seams.

D. Do not locate longitudinal seams on bottom of duct.

3.5 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

3.6 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Double Wall:

1. Ductwork complies with requirements in "Double-Wall Rectangular Ducts and Fittings" or "Double-Wall Round Ducts and Fittings" Article.
2. Ductwork outer wall is to be aluminum indicated by manufacturer to be suitable for outdoor installation.
3. Provide interstitial insulation.

3.7 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.8 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. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."

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.

3.9 DUCTWORK CONNECTIONS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.10 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
3. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at

maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

    a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media is to not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.12 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. 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.

E. 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.

F. 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 in accordance with NADCA ACR. 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 in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.13 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: B.

2. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 3-inch wg.
    b. Minimum SMACNA Seal Class: A.

3. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: B.

3. Ducts Connected to Equipment Not Listed above:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

3. Ducts Connected to Equipment Not Listed above:

    a. Pressure Class: Positive or negative 3-inch wg.
    b. Minimum SMACNA Seal Class: B if negative pressure; A if positive pressure.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A.

F. Exterior Supply and Return/Exhaust Ducts:
1. Ducts Connected to all equipment:
    a. Pressure Class: Positive or negative 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. Double-wall construction.

G. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

H. Elbow Configuration:

1. Rectangular Duct - Requirements for Different Velocities: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Velocity 1000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1000 to 1500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
        3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

    c. Velocity 1500 fpm or Higher:

        1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct - Requirements for All Velocities: 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: Welded.

I. 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 spin in.

2. Round and Flat Oval: 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 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. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Smoke dampers.
5. Combination fire and smoke dampers.
6. Flange connectors.
7. Duct silencers.
8. Turning vanes.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

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

1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. American Warming and Ventilating; a Mestek Architectural Group company.
2. Cesco Products; a division of MESTEK, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.
7. Safe Air - Dowco Products.
8. United Enertech.
9. Vent Products Co., Inc.

B. Description: Gravity balanced.

C. Performance:

1. Maximum Air Velocity: 1250 fpm.
2. Maximum System Pressure: 2 inches wg.
3. AMCA Certification: Test and rate in accordance with AMCA 511.
4. Leakage:
   a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

D. Construction:

1. Frame:

   a. Hat shaped.
   b. 16-gauge- thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

2. Blades:

   a. Multiple single-piece blades.
   b. Off-center pivoted, maximum 6-inch width, 16-gauge- thick, with sealed edges.

3. Blade Action: Parallel.

E. Blade Seals: Neoprene, mechanically locked.

F. Blade Axles:

1. Material: Galvanized steel.
2. Diameter: 0.20 inch.

G. Tie Bars and Brackets: Galvanized steel.

H. Return Spring: Adjustable tension.

I. Bearings: Steel ball Brass sleeve or synthetic pivot bushings.

J. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Chain pulls.
4. Screen Mounting:

a. Front mounted in sleeve.

1) Sleeve Thickness: 20 gauge minimum.
2) Sleeve Length: 6 inches minimum.

5. Screen Material: Aluminum.
6. Screen Type: Bird.
7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Air Balance; a division of MESTEK, Inc.
b. Aire Technologies, Inc.; a DMI company.
c. Greenheck Fan Corporation.
d. Lloyd Industries, Inc.
e. McGill AirFlow LLC.
f. Nailor Industries Inc.
g. Ruskin Company.

2. Performance:

a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:

    a. Linkage out of airstream.
    b. Suitable for horizontal or vertical airflow applications.

4. Frames:

    a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized steel; 16 gauge thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated stainless steel sleeve.
    b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8. Tie Bars and Brackets: Galvanized steel.
9. Locking device with offset handle to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

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

    a. American Warming and Ventilating; a Mestek Architectural Group company.
    b. Arrow United Industries.
    c. Cesco Products; a division of MESTEK, Inc.
    d. McGill AirFlow LLC.
    e. Nailor Industries Inc.
    f. Pottorff.
    g. Ruskin Company.
    h. Safe Air - Dowco Products.
    i. United Enertech.

j. Vent Products Co., Inc.

2. Performance:

   a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:

   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.

4. Frames:

   a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
   b. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
   e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

6. Blade Axles: Galvanized steel.
7. Bearings:

   a. Oil-impregnated bronze Molded synthetic Stainless steel sleeve.
   b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8. Tie Bars and Brackets: Aluminum.
9. Locking device with offset handle to hold damper blades in a fixed position without vibration.

C. Low-Leakage, Steel, Manual Volume Dampers:

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

   a. Air Balance; a division of MESTEK, Inc.
   b. American Warming and Ventilating; a Mestek Architectural Group company.
   c. Arrow United Industries.
   d. Cesco Products; a division of MESTEK, Inc.

e. Greenheck Fan Corporation.
f. McGill AirFlow LLC.
g. Nailor Industries Inc.
h. Pottorff.
i. Ruskin Company.
j. Safe Air – Dowco Products.
k. United Enertech.
l. Vent Products Co., Inc.

2. Performance:

a. AMCA Certification: Test and rate in accordance with AMCA 511.
b. Leakage:
1) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:

a. Linkage: Out of airstream.
b. Suitable for horizontal or vertical airflow applications.

4. Frames:

a. Hat, U, or angle shaped.
b. Thickness: 16-gauge galvanized sheet steel.
c. Mitered and welded corners.
d. 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, roll-formed steel; 16 gauge thick.

6. Blade Edging Seals:

a. Closed-cell neoprene.
b. Inflatable seal blade edging or replaceable rubber seals.

7. Blade Jamb Seals: Neoprene.
8. Blade Axles: Galvanized steel.
9. Bearings:

a. Oil-impregnated stainless steel sleeve.

b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

10. Tie Bars and Brackets: Galvanized steel.
11. Locking device with offset handle to hold damper blades in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:

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

   a. Air Balance; a division of MESTEK, Inc.
   b. American Warming and Ventilating; a Mestek Architectural Group company.
   c. Arrow United Industries.
   d. Cesco Products; a division of MESTEK, Inc.
   e. McGill AirFlow LLC.
   f. Nailor Industries Inc.
   g. Pottorff.
   h. Ruskin Company.
   i. Safe Air - Dowco Products.
   j. United Enertech.
   k. Vent Products Co., Inc.
2. Performance:
   a. Leakage:
      1) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:

   a. Linkage out of airstream.
   b. Suitable for horizontal or vertical airflow applications.

4. Frames:

   a. Hat, U, or angle shaped.
   b. Thickness: 0.08-inch aluminum sheet channels.
   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. Roll-Formed Aluminum Blades:0.072-inch thick aluminum sheet.
d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

6. Blade Edging Seals:

a. Closed-cell neoprene.
b. Inflatable seal blade edging or replaceable rubber seals.

7. Blade Jamb Seals: Neoprene.
8. Blade Axles: Nonferrous metal.
9. Bearings:

a. Molded synthetic Stainless steel sleeve.
b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.

10. Tie Bars and Brackets: Aluminum.
11. Locking device with offset handle to hold damper blades in a fixed position without vibration.

E. Jackshaft:
1. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
2. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

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

1. Air Balance; a division of MESTEK, Inc.
2. Arrow United Industries.
3. Cesco Products; a division of MESTEK, Inc.
4. Greenheck Fan Corporation.
5. NCA Manufacturing, Inc.
6. Pottorff.

7. Ruskin Company.
8. Safe Air - Dowco Products.
9. United Enertech.
10. Vent Products Co., Inc.

B. Type: dynamic; rated and labeled in accordance with UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed galvanized sheet steel, interlocking. Material gauge is to be in accordance with UL listing.

I. Horizontal Dampers: Include blade lock and stainless steel closure spring.

J. Heat-Responsive Device:

1. Replaceable, 165 deg F rated, fusible links.

2.5 SMOKE DAMPERS

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

1. Air Balance; a division of MESTEK, Inc.
2. Arrow United Industries.
3. Cesco Products; a division of MESTEK, Inc.
4. Greenheck Fan Corporation.
5. Pottorff.
6. Ruskin Company.
7. Safe Air - Dowco Products.
8. United Enertech.

B. General Requirements:

1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.
4. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.
5. Factory install damper actuator by damper manufacturer as integral part of damper assembly. Coordinate actuator location, mounting, and electrical requirements with damper manufacturer.

C. Performance:

1. Leakage:
   a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
2. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm.
4. Temperature: Minus 25 to plus 180 deg F.
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

1. Suitable for horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
   a. Hat shaped.
   b. Galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
   c. Gauge in accordance with UL listing.
4. Blades:
   a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
   b. Maximum width and gauge in accordance with UL listing.
5. Blade Edging Seals:
   a. Silicone rubber.
6. Blade Jamb Seal: Flexible stainless steel, compression type.

7. Blade Axles: 1/2-inch diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage is to be mounted out of airstream.
8. Bearings:

    a. Oil-impregnated stainless steel sleeve.

E. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.

F. Damper Actuator - Electric:

1. Electric - 120 V ac.
2. UL 873, plenum rated.
3. Designed to operate in smoke-control systems complying with UL 555S requirements.
4. Two position with fail-safe spring return.

    a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
    b. Maximum 15-second full-stroke closure.
    c. Minimum 90-degree drive rotation.

5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:

    a. Temperature: Minus 40 to plus 130 deg F.
    b. Humidity: 5 to 95 percent relative humidity noncondensing.

7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with single-point wiring connection.

G. Controllers, Electrical Devices, and Wiring:
1. Electrical Connection: 115 V, single phase, 60 Hz.

H. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, damper mounted.
3. Smoke Detector: Integral, factory wired for single-point connection.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Air Balance; a division of MESTEK, Inc.
2. Arrow United Industries.
3. Cesco Products; a division of MESTEK, Inc.
4. Greenheck Fan Corporation.
5. Pottorff.
6. Ruskin Company.
7. Safe Air - Dowco Products.
8. United Enertech.

B. General Requirements:

1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: [**1-1/2**] [**and**] [**3**] hours.

E. Performance:
1. Leakage:

a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.

2. Pressure Drop: 0.05 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm.
4. Temperature: Minus 25 to plus 180 deg F.
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:

1. Suitable or horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:

    a. Hat shaped.
    b. Galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
    c. Gauge is to be in accordance with UL listing.

4. Blades:

    a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
    b. Maximum width and gauge in accordance with UL listing.

5. Blade Edging Seals:

    a. Silicone rubber.

6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
8. Bearings:

    a. Oil-impregnated stainless steel sleeve.

G. Mounting Sleeve:

1. Factory installed, galvanized sheet steel.
2. Length to suit wall or floor application.
3. Gauge in accordance with UL listing.

H. Heat-Responsive Device:

1. Replaceable, 165 deg F rated, fusible links.

I. Master control panel for use in dynamic smoke-management systems.

J. Damper Actuator - Electric:

1. Electric - 120 V ac.
2. UL 873, plenum rated.
3. Designed to operate in smoke-control systems complying with UL 555S requirements.
4. Two position with fail-safe spring return.

a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
b. Maximum 15-second full-stroke closure.
c. Minimum 90-degree drive rotation.

5. Clockwise or counterclockwise drive rotation as required for application.
6. Environmental Operating Range:

a. Temperature: Minus 40 to plus 130 deg F.
b. Humidity: 5 to 95 percent relative humidity noncondensing.

7. Environmental Enclosure: NEMA 2.
8. Actuator to be factory mounted and provided with single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:

1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:

1. Auxiliary switches for signaling or position indication.
2. Test and reset switches, damper mounted.
3. Smoke Detector: Integral, factory wired for single-point connection.

2.7 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.
2. DynAir; a Carlisle Company.
3. Elgen Manufacturing.

B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.8 DUCT SILENCERS

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

1. FläktGroup.
2. Flexmaster U.S.A., Inc.
3. McGill AirFlow LLC.
4. Pottorff.
5. Ruskin Company.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

D. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.

E. Round Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22 gauge thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20 gauge thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 18 gauge thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 16 gauge thick.

F. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 22 gauge thick, and with 1/8-inch- diameter perforations.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss.

H. Connection Sizes: Match connecting ductwork unless otherwise indicated.

I. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.

3. Lining: Fiberglas cloth.

J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: Lock formed and sealed or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Source Quality Control:

1. Test in accordance with ASTM E477.
2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.9 TURNING VANES

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

1. Aero-Dyne Sound Control Co.
2. Duro Dyne Inc.
3. DynAir; a Carlisle Company.
4. Elgen Manufacturing.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate 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"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:
1. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.10 REMOTE DAMPER OPERATORS

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

1. DynAir; a Carlisle Company.
2. METALAIRE, Inc.
3. United Enertech.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Aluminum.

D. Cable: Steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.11 DUCT-MOUNTED ACCESS DOORS

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

1. Aire Technologies.
2. Arrow United Industries.
3. Cesco Products; a division of MESTEK, Inc.
4. Duro Dyne Inc.
5. McGill AirFlow LLC.
6. Ruskin Company.
7. United Enertech.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 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. 24-gauge- thick galvanized steel door panel.
d. Vision panel.
e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
f. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum Insert value frame.

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: Continuous and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches: Continuous and two compression latches with outside and inside handles.

2.12 DUCT ACCESS PANEL ASSEMBLIES

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Access panels used in cooking applications:

1. Labeled compliant to NFPA 96 for grease duct access doors.
2. Labeled in accordance with UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 16-gauge carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10 inches wg positive or negative.

2.13 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. DynAir; a Carlisle Company.
4. Elgen Manufacturing.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. 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.

G. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

2.14 DUCT ACCESSORY HARDWARE

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Duro Dyne Inc.
4. Elgen Manufacturing.
5. United Enertech.

B. 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.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.15 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 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 backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

E. 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.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

H. Install fire and smoke dampers in accordance with UL listing.

I. Connect ducts to duct silencers with flexible duct connectors.

J. 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 from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-ft. spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. For grease ducts, install at locations and spacing as required by NFPA 96.
11. Control devices requiring inspection.
12. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. 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.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

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 size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233346 - FLEXIBLE DUCTS

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. Non-insulated flexible ducts.
2. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.

1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED 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; a brand of Hart & Cooley, Inc.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts 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 in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:

1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233423 - HVAC POWER VENTILATORS

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. Ceiling-mounted ventilators.
   2. Centrifugal ventilators - roof downblast.
   3. Centrifugal ventilators - roof upblast and sidewall.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2. Rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Certified fan performance curves with system operating conditions indicated.
   4. Certified fan sound-power ratings.
   5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6. Material thickness and finishes, including color charts.
   7. Dampers, including housings, linkages, and operators.
   8. Prefabricated roof curbs.
   9. Fan speed controllers.

B. Shop Drawings:

   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED VENTILATORS

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Steel, lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

D. Back-draft damper: Integral.

E. Grille: Plastic, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry.

B. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

6. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 24 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Pitch Mounting: Manufacture curb for roof slope.
6. Metal Liner: Galvanized steel.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

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

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry; division of Air System Components.

B. Configuration: Centrifugal roof upblast, grease hood kitchen ventilator.

C. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Provide grease collector.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5hp.
6. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted insidefan housing, factory wired through an internal aluminum conduit.
3. Spark-resistant, all-aluminum wheel construction.
4. Mounting Pedestal: Galvanized steel with removable access panel.
5. Wall Mount Adapter: Attach wall-mounted fan to wall.
6. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

G. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange
2. Overall Height: To allow for fan discharge to be 40 inches above roof surface.
3. Sound Curb: Curb with sound absorbing and galvanized metal liner.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Pitch Mounting: Manufacture curb for roof slope.
6. Metal Liner: Galvanized steel.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. NFPA 96 code requirements for commercial cooking operations.
9. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.5 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

E. Operating Limits: Classify according to AMCA 99.

F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

A. Install power ventilators level and plumb.

B. Secure roof-mounted fans to roof curbs with zinc-plated hardware.

C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

D. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch.

E. Install units with clearances for service and maintenance.

F. Install and secure roof mounted units in accordance with local wind loading requirements.

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
   1. Nameplate shall 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: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. 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 there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
6. Adjust belt tension.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

SECTION 233533 - LISTED KITCHEN VENTILATION SYSTEM EXHAUST DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire Resistive Listed grease ducts.
2. Access doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for listed grease ducts.

B. Shop Drawings: For listed grease ducts.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly of hangers and seismic restraints.

1.4 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in listed grease ducts and field-fabricated grease ducts.

PART 2 - PRODUCTS

2.1 LISTED GREASE DUCTS

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. Ampco Stacks; DuraVent.
2. McGill AirFlow LLC.
3. Metal-Fab, Inc.
4. Jeremias International
5. Van-Packer Co.

B. Description: Complete system, Factory-fabricated, -listed, and -labeled, double-wall ducts listed for 2 hour fire-resistance and zero clearance to combustibles. Tested according to UL 1978, UL 2221 and rated for 500 deg F continuously, or 2000 deg F for 30 minutes; with positive or negative duct pressure and complying with NFPA 96.

C. Construction: Inner shell and outer jacket separated by annular space filled with high-temperature, 3 inches of ceramic-fiber insulation.

1. Inner Shell: ASTM A666, stainless steel.
2. Outer Jacket: Stainless steel.

D. Gaskets and Flanges: Ensure that gaskets and sealing materials are rated at 1500 deg F minimum.

E. Hood Connectors: Constructed from same material as grease duct with internal or external continuously welded or brazed joints.

F. Grease duct cleanouts, openings, and reservoirs shall be provided and comply with the 2020 Mechanical Code of NYS.

G. Grease Duct Supports: Construct duct bracing and supports from non-combustible material.

1. Design bracing and supports to carry static and seismic loads within stress limitations of the International Building Code.
2. Ensure that bolts, screws, rivets and other mechanical fasteners do not penetrate duct walls.

H. Comply with ASTM E814.

I. Factory Tests: Test and inspect fire resistance of grease duct system according to ASTM E814.

1. Allow consultant two days' minimum notification before test is performed.

2.2 ACCESS DOORS

A. Description: Factory-fabricated, -listed, and -labeled, double-wall personnel and maintenance access doors tested according to UL 1978, UL 2221 and rated for 500 deg F continuously, or 2000 deg F for intermittent operation and complying with NFPA 96.

B. Listed access doors shall be provided, spaced and located in accordance with the requirements of NFPA 96.

C. An approved sign shall be placed on access opening panels with wording as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 96 and UL 2221, whichever is most stringent.

B. Ducts shall be installed as per manufacturer’s requirements at a slope toward the hood or toward grease reservoir. Where horizontal ducts exceed 75 feet in length, the slope shall be per manufacturer’s requirements.

D. Seal between sections of grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.

E. Connections: Make grease duct connections according to the International Mechanical Code.

1. Grease duct to exhaust fan connections: Connect grease ducts to inlet side of fan using flanges, gaskets, and bolts.
2. Grease duct to hood connections:

    a. Make grease duct to hood joints connections using internal or external continuously welded or brazed joints.
    b. Make watertight grease duct to hood joints connections using flanges, gaskets, and bolts.

F. Support ducts at intervals recommended by manufacturer to support weight of ducts and accessories, without applying loading on kitchen hoods.

    1. Securely attach supports and bracing to structure.

G. Repair damage to adjacent materials caused by listed kitchen ventilation system exhaust ducts installation.

3.3 FIELD QUALITY CONTROL

A. Perform air leakage test before concealment of any portion of the grease duct system.

    1. Notify Owner a minimum of two days before test is performed.

END OF SECTION 233533

SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.

C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.

D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.2 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 Refer to schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers 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 with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.

C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.

D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

1.2 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 Refer to schedules on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 237220 - ENERGY RECOVERY VENTILATORS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include packaged, outdoor, fixed-plate, energy-recovery-unit rated capacities, operating characteristics, furnished specialties, and accessories.
2. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

B. Shop Drawings: For packaged, outdoor, fixed-plate, energy-recovery ventilators.

1. Include plans, elevations, sections, details, and mounting attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, lifting requirements, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.2 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, roof plans, elevations, and other details, drawn to scale. and coordinated with each other, using input from installers of items involved.

B. Field quality-control reports.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged, outdoor, fixed-plate, energy-recovery equipment to include in maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed. Package with protective covering for storage and identify with labels describing contents.

1. Filters: One set(s) of each type of filter specified.
2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery ventilators.

1.5 COORDINATION

A. Coordinate sizes and locations of building openings and duct connections with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, outdoor, fixed-plate, energy-recovery ventilators that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Energy-Recovery ventilators: One year(s) from date of Substantial Completion.
2. Warranty Period for Fixed-Plate Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1.
2. Capacity ratings for fixed-plate energy-recovery ventilators shall comply with ASHRAE 84.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. UL Compliance:

1. Packaged heat-recovery ventilators shall comply with requirements in UL 1815 or UL 1812.
2. Electric coils shall comply with requirements in UL 1995.

E. Comply with ASTM E84 or UL 723.

2.2 ENERGY-RECOVERY VENTILATORS – Standard construction

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

1. Greenheck Fan Corporation.
2. Venmar CES Inc.
3. RenewAire.

B. Source Limitations: Energy-recovery ventilators from single manufacturer.

C. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1.

D. Housing: Manufacturer's double wall construction with corrosion-protection coating and exterior finish, gasketed, hinged access doors or removable panels with neoprene gaskets for inspection and access to internal parts, minimum 2-inch thick, thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

E. Fixed-Plate, Heat Exchanger:

1. Casing: Aluminum.

a. Comply with requirements in ASHRAE 62.1.

2. Plates: Evenly spaced, sealed, and arranged for counter-flow.

1. Plate Material: Chemically treated paper, or polymer on aluminum, with selective hydroscopicity, moisture permeability, and gas barrier properties.

F. Supply and Exhaust Fans: Forward-curved centrifugal fan with spring isolators or restrained spring isolators of 1-inch static deflection.

1. Motors and Drives: Direct driven.
   a. Motor Sizes: Minimum size as indicated. If size is not indicated, provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Filters:

1. Description: Cleanable wire mesh at outside air intake and pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. UL Compliance: Comply with UL 900.
3. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
4. Filter Media Frame: Beverage board with perforated metal retainer or metal grid on outlet side.
5. Filter-Mounting Frames: Arranged with access doors or panels on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

H. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
2. Include nonfused disconnect switches.

2.3 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by NRTL, and marked for intended location and application.

B. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060IP.

C. Fan Performance Rating: Comply with AMCA 211, and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210 and ASHRAE 51.

D. Fan Sound Ratings: Comply with AMCA 301 or AHRI 260IP.

E. UL Compliance:

1. Packaged, Fixed-Plate, Energy-Recovery Units: Comply with requirements in UL 1812.
2. Electric Coils: Comply with UL 1995.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before packaged, outdoor, fixed-plate, energy-recovery unit installation. Replace insulation materials and filter media that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION OF ENERGY-RECOVERY VENTILATORS

A. Install energy-recovery ventilators, so supply and exhaust airstreams flow in opposite directions.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to interior components.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.

B. Install roof-mounted energy-recovery ventilators on dunnage.

C. Install indoor, floor-mounted energy-recovery ventilators on concrete pads where shown or equipment stand.

D. Install indoor, ceiling suspended energy recovery ventilators using threaded steel rods and spring hangers.

E. Install units with clearances for service and maintenance.

F. Do not operate equipment fans until temporary or permanent filters are in place. Replace temporary filters used during construction and testing with new, clean filters prior to final inspection.

3.3 DUCTWORK CONNECTIONS

A. Connect duct to units with flexible connections.

3.4 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs.

2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.6 STARTUP SERVICE

A. Engage factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity setpoints.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with assistance of factory-authorized service representative.

E. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Energy-recovery ventilators will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain energy-recovery ventilators.

END OF SECTION 237220

SECTION 237223 – ENERGY RECOVERY UNITS

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged energy recovery or cooling units with the following energy recovery device:
   a. Aluminum Wheel
2. Packaged Cooling
3. Packaged Controls

1.2 SUBMITTALS

A. Product Data: For each type of product indicated, include all rated capacities at scheduled design conditions, operating characteristics, general product features, options and accessories, controls, pre-programmed controls sequences, all end devices, and unit warranties provided.

B. Shop Drawings: For air-to-air energy recovery equipment, include plans, elevations, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, corner weights, required clearances, components, and location and size of each field connection.

C. Factory start-up, inspection, and check-out reports to be provided to engineer for review prior to final equipment acceptance, startup, or commissioning. See section 2.2 for more information.

D. Operation and Maintenance Data to be provided with unit at shipment including Mechanical O&M and Controls Instructions and O&M.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1-2013, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Startup."
2. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.

C. ANSI Z83.8 and CSA 2.6 standards for gas fired equipment

D. UL Compliance:

1. Unit shall be ETL listed per UL standard 1995 and CSA standard C22.2 #236

1.4 COORDINATION

A. Coordinate sizes and locations of equipment supports, and roof penetrations with equipment provided.

B. Coordinate sizes and locations of concrete bases with equipment provided.

C. Coordinate locations of connecting utilities including: water, gas, electric, controls, and condensate with equipment provided.

1.5 DELIVERY AND HANDLING

A. Unit shall be shipped with door handles locked shut with door handle set screws and outside air hood closed to prevent damage during transport and temporary storage.

B. Follow IOM instructions for rigging and unloading the unit at its final location.

C. Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the IOM.

1.6 WARRANTY

A. Unit Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment which fail in materials or workmanship within specified warranty period. Warranty period shall begin at startup, or six months after shipment, whichever occurs first:

1. Parts Warranty Period for Packaged Energy Recovery Units: One (1) year.
2. Parts Warranty Period for Compressors: Five (5) years.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed.
1. Filters: One set of each type of filter specified.

PART 2 – PRODUCTS

2.1 PACKAGED ENERGY RECOVERY UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Trane, American Standard Companies, Inc.
2. Valent
3. AAON, Inc.
4. Carrier Corporation
5. McQuay International
6. YORK International Corporation

B. Unit Construction:

1. Base: Manufacturer's standard base shall be constructed of minimum 10 gage galvanized steel with 16 gage integral floor pan. Floor pan shall be insulated with minimum 1/4" closed cell neoprene liner. All floor seams shall have a raised rib joint. Penetrations through the floor shall have a minimum 3/8" raised rib around each opening. Base shall have a minimum 4" overhang over the top of dunnage to prevent water infiltration.
2. Panels: Manufacturer's standard casing shall be constructed of minimum 2-inch, foam-injected, double-wall panels.
    a. Individual panels shall be constructed so that there is no metal-to-metal contact between the interior and exterior sheet metal of each panel.
    b. Interior side of panel shall be 22 gage G-90 galvanized steel. Exterior side of panel shall be 22 gage pre-painted steel rated for 1000 hours of salt spray exposure in accordance with ASTM B117 and ASTM D1654.
    c. Insulation shall be 2 lb/ft^3 injected foam insulation with a minimum R-value of 12. Foam sheet or fiberglass insulation are not acceptable due to reduced durability of panel and increased chance for rust forming between the panels. Insulation water absorption must be no more than 0.038 lb/ft per ASTM D2842 and show "no growth" per ASTM G21 biocide testing. Interior sheet metal shall encase insulation so that it is not exposed to the airstream.
3. Access doors shall be provided for access to all internal components requiring regular maintenance or inspection. Access door construction and materials shall be identical to unit casing. Access doors shall have galvanized hinges and a minimum of two quarter-turn compression latches with adjustable catches. Access doors shall be sealed with a full-perimeter D-shaped gasket constructed of EPDM sponge rubber.

4. Roof shall be pitched away from access doors and include a minimum ½" overhang around the perimeter of the unit.
5. Outdoor Air Inlet: Outdoor units shall be provided with a factory provided, field-assembled weather hood with ½" aluminum washable filters on the outdoor air inlet. Indoor units shall be provided with duct connections at the outdoor air inlet.
6. Unit return shall be up flow or horizontal through a plenum curb.
7. Unit discharge shall be horizontal flow without the need for a plenum curb.
8. Unit shall include lifting eyes on top of unit for use during rigging.
9. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
10. Motorized dampers – Outside Air and Return Air
    a. Frame shall be constructed of a 16 gage galvanized steel hat-channel.
    b. Blades shall be constructed of 16 gage galvanized steel strengthened by three longitudinal 1 inch deep "vee" grooves.
    c. Blades shall be symmetrical relative to its axle pivot point.
    d. Axle bearings shall be synthetic sleeve-type and rotate inside extruded holes in the damper frame.
    e. Blade seals shall be extruded vinyl permanently bonded to the appropriate blade edges.
    f. Frame shall include flexible stainless steel compression-type jamb seals.
    g. Modulating spring-return actuators shall be provided by the factory, installed on the damper, and wired to the control center. Each damper shall have a dedicated actuator. Single actuators with gear trains are not acceptable.
    h. Damper leakage shall be no more than 3 cfm/sq.ft. at 1 in.wg static pressure.
11. Exhaust: Gravity backdraft damper with internal bird screen. Indoor units shall have duct flanges for connection to exhaust ductwork.

C. Heat Recovery Device: Heat Wheel – Aluminum substrate with 4 angstrom molecular sieve desiccant.

1. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
2. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
3. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
4. Energy recovery wheel media shall be constructed of fluted aluminum with permanently-bonded zeolite desiccant.

5. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
6. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
7. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
8. Rotor media shall be reinforced using aluminum structural spokes with extruded central hub and shaft and shall be connected to shaft using pillow bearings.
9. Energy wheel cassette shall include seals, drive motor, and linked drive belt.
10. Latent energy shall be transferred entirely in the vapor phase with no condensation.
11. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories Recognized Component for electrical and fire safety.
12. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

D. DX Cooling Coil:

1. Coil shall be rated in accordance to AHRI standards, designed to withstand 250 psig working pressure at 300 degrees F, and pressure tested to 600 psig.
2. Coil shall be a minimum of 4 or 6 rows deep with maximum fin density of 16 fins per inch.
3. Refrigeration systems with more than one circuit shall have interlaced evaporator coils.
4. Coil casing shall be constructed of 16 gage 304 stainless steel.
5. Coil tubes shall be constructed of 1/2" diameter, 0.016" thick seamless copper tubing.
6. Coil fins shall be constructed of 0.0060" thick aluminum.
7. Coil shall be hydrogen or helium leak tested.
8. Drain pan

    a. Drain pan shall be constructed of a minimum of 18 gage 201 stainless steel.
    b. Drain pan shall be double-sloped to ensure condensate removal from unit.
    c. Drain pan shall extend a minimum of 8” past the evaporator coil to ensure condensate retention.

E. Refrigeration – Air Cooled DX:

1. Unit shall be provided with factory piped, charged, and tested packaged air-cooled direct expansion refrigeration system.
2. Unit shall be factory charged with R-410A refrigerant.
3. Refrigeration systems 13 nominal tons and above shall be equipped with two stages of capacity control, each stage on an independent refrigerant circuit.

4. Refrigeration systems 25 or 30 nominal tons and above shall be equipped with four stages of capacity control, two stages per independent circuit.
5. Refrigeration system shall be provided with thermal expansion valve (TXV) incorporating adjustable superheat.

F. Compressors:

1. Compressors shall be hermetic scroll type and include the following items:

    a. Suction and discharge isolation valves.
    b. Reverse rotation protection.
    c. Oil level adjustment.
    d. Oil filter.
    e. Filter drier
    f. Short cycling control.
    g. High and low pressure limits.
    h. Crankcase heaters.
    i. Thermal overload.
2. Compressors shall be installed in a separate compartment which can be accessed without affecting unit operation, above the unit floor, and isolated from the surrounding environment by double wall foam injected panels and access doors.
3. Compressors shall be installed using manufacturer's recommended rubber vibration isolators.
4. Capacity control shall be provided through the use of a single Digital Scroll™ scroll compressor. Additional compressors, if required, shall be fixed stage scroll compressors.

G. Air Cooled Condenser:

1. Air cooled condenser coil shall be unit mounted.
2. Provide condenser coils with galvanized casing, seamless copper tubes, and aluminum fins.
3. Coil shall be rated in accordance to AHRI standards, designed to withstand 250 psig working pressure at 300 degrees F, and pressure tested to 600 psig.
4. Coil casing shall be constructed of 16 gage galvanized steel.
5. Coil tubes shall be constructed of 5/16" diameter, 0.012" thick seamless copper tubing.
6. Coil fins shall be constructed of 0.0060" thick aluminum fins.
7. Coil shall be hydrogen or helium leak tested.
8. Condenser coils shall be mounted at a minimum 30 degree angle from vertical to help prevent hail damage.

H. Condensing Fans – Low ambient and Low sound:

1. Condensing section shall be equipped with high-performance 1200 rpm condensing fans.
2. Condensing fan blades shall be constructed out of a polymer, sickle-shaped blades with serrated trailing edges for sound reduction. Individual fans shall be capable of an Lw(A) of 75 dB as tested to ISO 5801.
3. Condensing fan motor shall be electrically-commutated and capable of modulation without the need of an external variable frequency drive.
4. All condensing fans shall modulate in unison to maintain the head pressure set point.

I. Direct Drive Supply and Exhaust Airflow Blowers:

1. Fan assemblies shall be direct-drive without the use of belts or adjustable sheaves.
2. A variable frequency drive (VFD) shall be provided for each fan section. VFD shall be mounted, wired, and programmed by the equipment manufacturer. VFD shall be located in an enclosed compartment outside of the supply or exhaust air stream.
3. Fan wheels shall be constructed of a minimum of seven, stitch welded backward curved aluminum blades
4. Fan wheel shall be tested in accordance to AMCA 210. Fan speed shall not exceed 2400 RPM.
5. Fans may be full width or partial width. Fans modified to partial width through the use of banding or other blade reduction method are not acceptable.
6. Fans shall be mounted on minimum 1” tall neoprene isolators.
7. Fan motor shall be VFD rated, ODP type, EPACT compliant, and shall be of premium efficiency (PE).

J. Filters:

1. Outdoor air intake hood filters

    a. Filter rack shall accommodate 1" media.
    b. Manufacturer shall provide 1 set of 1" aluminum filter media.
    c. Filter sections shall be accessible from outside the unit and located in the outdoor air intake hood.

2. Outdoor air filters

    a. Outdoor air filter rack shall accommodate factory-provided 2" MERV 8 filters.
    b. Filter sections shall be accessible through a 2" foam-injected, double-wall, hinged access door with quarter-turn latches.

3. Return air filters

a. Return air filter rack shall accommodate factory-provided 2" MERV 8 filters.
b. Filter sections shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.

4. Supply air filters

a. Supply air filter rack shall accommodate factory-provided 4" MERV 14 with leading 2" MERV 8 filters.
b. Filter sections shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
c. Filter section shall include magnehelic gauge and dirty filter pressure switch.

K. Electrical:

1. Unit shall be constructed with an integral electrical and control center isolated from supply airflow, exhaust airflow, compressors, and heating elements. The control center shall control all aspects of the unit operation. VFDs with overload protection shall be provided for each fan bank.
2. Units shall be wired according to NEC and listed per ETL. ETL listing shall cover all components of the ventilator and not be limited to the control panel. All major electrical components shall be UL or ETL listed.
3. Unit shall have a single point of connection with integral unit mounted disconnect. Panel shall have an SCCR rating of 5 kV.
4. Units shall be factory wired with a single point power connection.
5. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 7% out of balance on voltage, the voltage is more than 7% under design voltage, or on phase reversal.
6. The following items shall be provided and wired within the control center by the factory:
   a. Non-fused disconnect.
   b. Sub-circuit fusing.
   c. Low voltage transformers.
   d. Controls as specified in this section.
   e. Control circuit fusing.
   f. Terminal block.
   g. Supply and Exhaust Fan motor Variable Frequency Drives (VFDs).
7. Electrical panel must house all high voltage components such as terminal blocks, variable frequency drives, and fuse blocks.
8. All electrical power and controls wiring shall run in chase located between unit ceiling and roof to minimize interior wall penetrations and allow for ease of access.
9. Options

a. Control panel shall include a factory supplied and mounted 115V GFCI convenience outlet receptacle with a 12A circuit breaker. Outlet shall be powered by the main power.
b. Unit shall include a factory supplied, mounted, and wired electric heating element in the control panel to maintain a minimum of 0F in the panel.

L. Controls:

1. Units shall include factory supplied, mounted, wired, and tested stand-alone microprocessor controls.
2. Microprocessor controller shall be factory-programmed for discharge air control and use an internal 7-day time clock.
3. Microprocessor controller shall include local liquid crystal display (LCD) for user interface. Microprocessor controller remote LCD shall be mounted in a weatherproof enclosure and accessible without exposing the operator to high voltage wiring or having to turn off or circumvent the main disconnect.
4. Microprocessor controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
5. The following sensors shall be factory supplied, mounted, and wired inside the unit:

   a. Outdoor air humidity sensor.
   b. Outdoor air temperature sensor.
   c. Evaporator coil leaving air temperature sensor.
   d. Supply air filter pressure monitoring switch and magnehelic gauge.
   e. Energy wheel rotation sensor.
6. The following devices shall be factory-supplied for field installation and wiring:

   a. Supply air temp temperature sensor.
   b. Space static pressure sensor.
   c. Supply duct static pressure sensor.

7. Microprocessor controller shall include a Web UI interface for remote web-based access of all unit digital and analog inputs and outputs. Web UI shall include unit scheduling, point trending capabilities, and an alarm history.

8. Roof dunnage support shall incorporate integral spring-vibration isolation rail with adjustable 2" deflection isolators, properly sized and selected for unit point loading. Spring isolators shall have a minimum of 90% isolation efficiency.

2.2 FACTORY VERIFICATION TESTING

A. Unit shall be thoroughly run tested prior to shipment from the factory.

B. Factory run test report shall be provided at the request of the engineer, contractor, or owner.

C. Testing Procedures

1. Unit shall be subjected to and pass a dielectric (hipot) test.
2. All motorized dampers shall be cycled one full stroke while installed in the unit using the factory-provided motorized actuators.
3. Supply fan
    a. Visually inspect ramp-up, ramp-down, and rotation direction of fan when enabled.
    b. Verify fan pressure proving switch operation.
    c. Measure and record current draw through supply fan motor(s).
4. Exhaust fan
    a. Visually inspect ramp-up, ramp-down, and rotation direction of fan when enabled.
    b. Verify fan pressure proving switch operation.
    c. Measure and record current draw through exhaust fan motor(s).
5. Energy recovery wheel
    a. Visually inspect energy recovery wheel cassette is free to rotate within cassette.
    b. Visually inspect energy recovery belt drive mechanism.
    c. Enable energy recovery wheel motor and ensure proper rotation.
    d. Measure and record current draw through energy recovery wheel motor.
6. Condensing fans
    a. Ensure fans rotate freely without obstruction.
    b. Energize fans and ensure proper rotation.
    c. Measure and record the amount of current draw through each condensing fan.
7. Refrigeration system
    a. Measure and record subcooling and superheat on circuit A with hot-gas reheat valve closed (0%) after 15 minutes of steady-state operation.
    b. Measure and record subcooling and superheat on circuit A with hot-gas reheat valve open (100%) after 15 minutes of steady-state operation.
    c. Measure and record subcooling and superheat on circuit B after 15 minutes of steady-state operation.

D. Test report shall be provided prior to unit startup and available from the factory upon request.

PART 3 – EXAMINATION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that do not comply, or are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Unit Support:

1. Install roof mounted units on structural dunnage with pedestals to support energy recovery non-ducted end of unit as recommended by unit manufacturer.

B. Install units with clearances for service and maintenance.

C. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

D. Comply with ANSI Z223.1 and CGA B149.1 or CGA B149.2 for field gas piping and venting.

E. Pipe condensate drains from drain pans to nearest floor drain.

3.3 CONNECTIONS

A. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including all connections.

C. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized and crankcase heaters have had sufficient on-time, start units to confirm proper motor rotation and unit operation.
2. Enter or adjust all controller set-points as required to meet specific project requirements.
3. Set initial temperature and humidity set points.
4. Set field-adjustable switches as indicated.

D. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy recovery units.

END OF SECTION 237413

SECTION 237416.11 - PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, small-capacity, rooftop air-conditioning units (RTUs) with the following components:

1. Casings.
2. Fans, drives, and motors.
3. Coils.
4. Refrigerant circuit components.
5. Air filtration.
6. Dampers.
7. Electrical power connections.
8. Accessories.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, small-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.3 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.

d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. System startup reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set of filters for each unit.
2. Gaskets: One set for each access door.
3. Fan Belts: One set for each belt-driven fan.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 3 years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion
3. Warranty Period for Compressors: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. UL Compliance: Comply with UL 1995.

2.2 MANUFACTURERS

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

1. AAON.
2. Daikin Applied.
3. Trane.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
3. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
4. Casing Insulation:

a. Materials: Injected polyurethane foam insulation.
b. Casing Panel R-Value: Minimum 7
c. Insulation Thickness: 1 inch.
d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 3-inch wg.
2. For Unit Sections Downstream and Including Fans: 4-inch wg.

E. Panels and Doors:

1. Panels:

a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

2. Access Doors:

a. Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
b. Gasket: Neoprene, applied around entire perimeters of panel frames.
c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.

3. Locations and Applications:

a. Fan Section: Doors and inspection and access panels.
b. Access Section: Doors.
c. Coil Section: Inspection and access panels.
d. Damper Section: Doors.
e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
f. Mixing Section: Doors.

F. Condensate Drain Pans:

1. Location: Each type of cooling coil rotary heat exchanger.
2. Construction:

a. Single-wall, stainless steel sheet.

3. Drain Connection:

a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
b. Minimum Connection Size: NPS 1.

4. Slope: Minimum 0.125-in./ft. slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway.

2. Shaft Bearings:

a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
5. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
6. Shaft Lubrication Lines: Extended to a location outside the casing.
7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch- thick, galvanized-steel sheet.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

C. Drives, Direct: Factory-mounted, direct drive.

D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed ECM motors.

E. Relief-Air Fan: , shaft mounted on permanently lubricated motor.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Plate

3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

    a. Working Pressure: Minimum 300 psig.

C. Outdoor-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Platre

3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

    a. Working Pressure: Minimum 300 psig.

D. Hot-Gas Reheat Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Plate

3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

a. Working Pressure: Minimum 300 psig.

8. Suction-discharge bypass valve.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Hermetic, variable-speed scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

B. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

C. Refrigeration only controller.
1. DDC controller capable of running all components associated with the refrigerant circuit.

2.7 AIR FILTRATION

A. Panel Filters:

1. Description: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.

2.8 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.9 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Return-air bypass damper.

C. Factory- or field-installed, demand-controlled ventilation.

D. Safeties:
1. Condensate overflow switch.
2. Phase-loss reversal protection.
3. High and low pressure control.

E. Coil guards of painted, galvanized-steel wire.

F. Hail guards of galvanized steel, painted to match casing.

G. Door switches to disable heating or reset set point when open.

H. Outdoor-air intake weather hood.

I. Oil separator.

J. Service Lights and Switch: Factory installed in fan and coil sections with weatherproof cover. Factory wire lights to a single-point field connection.

2.10 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Spray.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.11 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.2 INSTALLATION

A. Unit Support: Install unit level on structural dunnage. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to RTU, allow space for service and maintenance.

C. Connect piping to unit mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, coils, and fans.
5. Inspect internal insulation.
6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean condenser coil and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.

14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.

20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

26. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

a. High-temperature limit on gas-fired heat exchanger.
b. Low-temperature safety operation.
c. Filter high-pressure differential alarm.
d. Economizer to minimum outdoor-air changeover.
e. Relief-air fan operation.
f. Smoke and firestat alarms.

28. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.7 CLEANING AND ADJUSTING

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. RTU will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237416.11

SECTION 238130 - VARIABLE-REFRIGERANT-FLOW SYSTEMS

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 complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:
   1. Indoor, exposed, wall-mounted units.
   2. Indoor, recessed, ceiling-mounted units.
   3. Outdoor, air-source heat recovery units.
   4. Heat recovery control units.
   5. System controls.
   6. System refrigerant and oil.
   7. System condensate drain piping.

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

E. Three-Pipe System Design: One high pressure refrigerant vapor line, one low pressure refrigerant vapor line, and one refrigerant liquid line connect a single outdoor unit or

multiple manifold outdoor units in a single system to associated system HRCUs. One liquid line and refrigerant vapor line connect HRCUs to associated indoor units.

F. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system HRCUs. One refrigerant liquid line and refrigerant vapor line connect HRCUs to associated indoor units. HRCUs used in two pipe systems act as an intermediate heat exchanger and include diverting valves and gas/liquid separators to move high and low pressure refrigerant between indoor units.

G. VRF: Variable refrigerant flow.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at NPES Hyde Park NY.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units and for HRCUs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit and HRCU control.
6. Include description of control software features.
7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
8. Include refrigerant type and data sheets showing compliance with requirements indicated.
9. For system design software.
10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
5. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For fully and partially exposed indoor units with factory finishes viewable by occupants.

1. Include a Sample for each unique finish with unit identification, detailed description of application, and cross-referenced floor plans showing locations.

D. Delegated-Design Submittals:
1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.
2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.
3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural floors, roofs and associated members to which equipment, piping,cables, and conduit will be attached.
3. Size and location of initial access modules for acoustical tile.
4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.
6. Items penetrating finished ceiling including the following:

a. Luminaires.

b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Service access panels.

B. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

C. Product Certificates: For each type of product.

The installing contractor shall have been certified by the manufacturer to install VRF systems, having attended and successfully completed a minimum 3- day VRF Service & Installation course at an approved training facility. A copy of this certificate shall be presented to the VRF manufacturer prior to the commencement of installation activity.

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

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranties: For manufacturer's warranties.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. One 1 set(s) for each unit with replaceable filters.

2. Indoor Units: One 1 for each unique size and type installed.
3. Controllers for Indoor Units: One 1 for each unique controller type installed.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five 5 years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least three 3 completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. In-place facility located within 60miles of Project.
3. Demonstrated past experience with products being installed for period within three 3 consecutive years before time of bid.

4. Demonstrated past experience on five 5 projects of similar complexity, scope, and value.

    a. Each person assigned to Project shall have demonstrated past experience.

5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.
7. Product parts inventory to support ongoing system operation for a period of not less than five 5 years after Substantial Completion.
8. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.

    a. Demonstrated past experience with products being installed for period within five 5 consecutive years before time of bid.
    b. Demonstrated past experience on five 5 projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.
2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

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

a. Structural failures.
b. Faulty operation.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: Seven 7 year(s) from date of Substantial Completion.
b. For Parts, Including Controls: Five 5 year(s) from date of Substantial Completion.
c. For Labor: No labor coverage provided by VRF manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin AC (Americas), Inc.
2. LG Electronics.
3. Samsung HVAC.
4. Trane Company

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.
2. Controls and software.
3. Refrigerant isolation valves.
4. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, HRCUs, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.
2. System(s) operation, air-conditioning heat recovery as indicated on Drawings.
3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.
2. ASHRAE 62.1: For indoor air quality.
3. ASHRAE 135: For control network protocol with remote communication.
4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design complete and operational VRF HVAC system(s) complying with requirements indicated.

1. Provide system refrigerant calculations.

a. Refrigerant concentration limits shall be within allowable limits of ASHRAE 15 and governing codes.
b. Indicate compliance with manufacturer's maximum vertical and horizontal travel distances. Prepare a comparison table for each system showing calculated distances compared to manufacturer's maximum allowed distances.

2. Include a mechanical ventilation system and gas detection system as required to comply with ASHRAE 15 and governing codes.
3. System Refrigerant Piping and Tubing:

a. Arrangement: Arrange piping to interconnect indoor units, HRCUs, and outdoor unit(s) in compliance with manufacturer requirements and requirements indicated.
b. Routing: Conceal piping above ceilings and behind walls to maximum extent possible.
c. Sizing: Size piping system, using a software program acceptable to manufacturer, to provide performance requirements indicated. Consider requirements to accommodate future change requirements.

4. System Controls:

a. Network arrangement.
b. Network interface with other building systems.
c. Product selection.
d. Sizing.

B. Service Access:

1. Provide and document service access requirements.
2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.
3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.
4. If less than full and unrestricted access is provided, locate components within an 18-inch (450-mm) reach of the finished assembly.
5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.
6. Comply with OSHA regulations.

C. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.
2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

D. System Adaptability to Future Changes: Arrange and size system refrigerant piping to accommodate future changes to system without having to resize and replace existing refrigerant piping.

1. Future changes to system(s) indicated on Drawings.
2. Each branch circuit shall accommodate addition of three 3indoor unit(s) with unit capacity equal to 54,000 BTUH indoor unit connected to the branch circuit.

E. Isolation of Equipment: Provide isolation valves to isolate each, indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

F. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Not less than 60 percent.
2. Not more than 130 percent.
3. Range acceptable to manufacturer.

G. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

H. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

I. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

    a. Design equipment and supports to withstand wind loads of governing code.
    b. Design equipment and supports to withstand snow and ice loads of governing code.
    c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

2. Maximum System Operating Outdoor Temperature: 120 deg. F.
3. Minimum System Operating Outdoor Temperature: -4 deg. F.

J. Sound Performance: Sound levels generated by operating HVAC equipment shall be within requirements indicated.

1. Indoor: Within design guidelines of "2015 ASHRAE HANDBOOK- HVAC Applications."
2. Outdoor: Within ordinance of governing authorities.

K. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

L. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, EXPOSED, WALL-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Gravity.

    a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

    a. Direct-drive arrangement.
    b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Front, to accommodate filter replacement without the need for tools.
2. Efficiency: minimum MERV 3 or based on manufacturers recommendation
3. Washable Media: Manufacturer's standard filter with antimicrobial treatment.

G. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.

H. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

I. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: Unit inlet air temperature Coil entering refrigerant temperature Coil leaving refrigerant temperature.
4. Field-Customizable I/O Capability:

    a. Analog Inputs: Two 2 for use in customizable control strategies.
    b. Digital Inputs: Two 2 for use in customizable control strategies.
    c. Digital Outputs: Two 2 for use in customizable control strategies.

5. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

J. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.5 INDOOR, RECESSED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
3. Mounting: Manufacturer-designed provisions for field installation.
4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Internal Tubing: Copper tubing with brazed joints.
6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.

b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.
2. Efficiency: ASHRAE 52.2, MERV 11.
3. Media:

a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
b. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
3. Additional Branch Supply Duct Connection: Sheet metal knockout for optional connection to one additional supply branch duct.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.

J. Unit Accessories:

1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control to satisfy unit control sequence of operation indicated on Drawings.
2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

K. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors: Unit inlet air temperature Coil entering refrigerant temperature Coil leaving refrigerant temperature.
4. Field-Customizable I/O Capability:

    a. Analog Inputs: Two 2 for use in customizable control strategies.
    b. Digital Inputs: Two 2 for use in customizable control strategies.
    c. Digital Outputs: Two 2 for use in customizable control strategies.

5. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification, power consumption display, drain assembly high water level safety shutdown and notification, run test switch.
6. Communication: Network communication with other indoor units and outdoor unit(s).
7. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
8. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

L. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring inraceways to comply with NFPA 70.

2.6 OUTDOOR, AIR-SOURCE HEAT RECOVERY UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with simultaneous heating and cooling.
2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.

    a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.
3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.
2. Protection: Integral protection against the following:

    a. High refrigerant pressure.
    b. Low oil level.
    c. High oil temperature.
    d. Thermal and overload.
    e. Voltage fluctuations.
    f. Phase failure and phase reversal.
    g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

4. Vibration Control: Integral isolation to dampen vibration transmission.
5. Oil management system to ensure safe and proper lubrication over entire operating range.
6. Crankcase heaters with integral control to maintain safe operating temperature.
7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

    a. Casing: Aluminum, galvanized, or stainless steel.
    b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
    c. Tubes: Copper, of diameter and thickness required by performance.

2. Aluminum Microchannel Coils:

    a. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
    b. Single- or multiple-pass arrangement.
    c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Coating: Corrosion resistant.
4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

    a. Direct-drive arrangement.
    b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
    c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
2. Factory-Installed Controller: Configurable digital control.
3. Factory-Installed Sensors:

    a. Refrigerant suction temperature.
    b. Refrigerant discharge temperature.
    c. Outdoor air temperature.
    d. Refrigerant high pressure.
    e. Refrigerant low pressure.
    f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch equalize run time between multiple same components.
5. Communication: Network communication with indoor units and other outdoor unit(s).
6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Raceways: Enclose line voltage wiring inraceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

2.7 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units, and outdoor units shall include integral controls and connect through a TIA-485A or manufacturer-selected BACnet control network.
2. Network Communication Protocol: open control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet MS/TP and certified by BACnet Testing Lab (BTL), including the following:

    a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.
    b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.
    c. Integration shall include control monitoring scheduling change of value notifications.

4. Operator Interface:

    a. Operators shall interface with system and unit controls through the following:

        1) Operator interfaces integral to controllers.
        2) Owner-furnished PC connected to central controller(s).
        3) Web interface through web browser software.
        4) Integration with Building Automation System.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.
2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
9. Supports Multiple Languages: English or Spanish.
10. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.
11. Displays service notifications and error codes.
12. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.
13. Monitors and displays cumulative operating time of indoor units.
14. Able to disable and enable operation of individual controllers for indoor units.
15. Information displayed on individual controllers shall also be available for display.
16. Information displayed for outdoor units, including refrigerant high and low pressures.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

    a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

    a. Sets schedule for daily, weekly, and annual events.
    b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.
10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Multiple Language: English or Spanish.
4. Temperature Units: Fahrenheit and Celsius.
5. On/Off: Turns indoor unit on or off.
6. Hold: Hold operation settings until hold is released.
7. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
8. Temperature Display: 1-degree increments.

9. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between 65-78 deg.F..
10. Relative Humidity Display: 1 percent increments.
11. Relative Humidity Set-Point: Adjustable in 1 percent increments between 40-60%RH.
12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to eight 8 events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Notification Display: "Filter" dirty.
18. Service Run Tests: Limit use by service personnel to troubleshoot operation.
19. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
21. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
22. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

2.8 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.
2. ASHRAE 34, refrigerant classification.
3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.9 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L (ASTM B88M, Type B) or Type DWV according to ASTM B306.
2. Wrought-Copper Fittings: ASME B16.22.
3. Wrought-Copper Unions: ASME B16.22.
4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.

D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.

2.10 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.
2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by manufacturer's service representative or system Installer under supervision of manufacturer's service representative.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch (10 mm).

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch (13 mm).

H. For floor- and wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.

I. Attachment: Install hardware for proper attachment to supported equipment.

J. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Install outdoor units on support structures indicated on Drawings.

C. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases.

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.
2. Grouting: Place grout under equipment supports and make bearing surface smooth.

D. Roof-Mounted Installations: Anchor units to supports with removable, stainless-steel fasteners.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors.

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors.

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.
2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

    a. Details indicated on Drawings.
    b. Manufacturer's requirements.
    c. Governing codes.
    d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of minimum of ¼-inch per foot.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.
b. Ensure that latest stable software release is installed and properly operating.
c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.
b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.
c. Disable dual network connections.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

a. Additional factory-authorized representatives may assist with completion of certain activities only if supervised by manufacturer's employee. A factory-authorized representative shall not provide assistance without manufacturer's employee supervision.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

a. First Visit: Kick-off meeting.
b. Second Visit: At approximately 25 percent completion of system(s).
c. Third Visit: At approximately 50 percent completion of system(s).
d. Fourth Visit: At approximately 75 percent completion of system(s).
e. Fifth Visit: Final inspection before system startup.

3. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.
b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.
c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.
2) Manufacturer's installation requirements specific to systems being installed.
3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.
4) Required field activities related installation of VRF HVAC system.
5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.
b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.
c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.
e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.
2) Date(s) and time frames while on-site.
3) Names and contact information of people meeting with while on-site.
4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.
b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.
c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection shall follow a detailed checklist specific to each equipment and operating component.
d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.

14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Unit airflow direction within an acceptable range.
19) If applicable, fan external static pressure setting.
20) Filter type and condition acceptable.
21) Noise level within an acceptable range.
22) Refrigerant piping properly connected and insulated.
23) Condensate drain piping properly connected and insulated.
24) If applicable, ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Condensate removal acceptable.
13) Noise level within an acceptable range.
14) Refrigerant piping properly connected and insulated.
15) Condensate drain piping properly connected and insulated.
16) Remarks.

f. Inspection reports for indoor, dedicated outdoor air ventilation units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity settings and readings within an acceptable range.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.
20) Noise level within an acceptable range.
21) Refrigerant piping properly connected and insulated.
22) Condensate drain piping properly connected and insulated.
23) Automatic dampers properly installed and operating.
24) Ductwork properly connected.
25) If applicable, external interlocks properly connected.
26) Remarks.

g. Inspection reports for energy recovery ventilators shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Humidity readings.
16) Condensate removal acceptable.
17) Fan settings and readings within an acceptable range.
18) Fan external static pressure setting.
19) Filter type and condition acceptable.

20) Noise level within an acceptable range.
21) Automatic dampers properly installed and operating.
22) Ductwork properly connected.
23) If applicable, external interlocks properly connected.
24) Remarks.

h. Inspection reports for hydronic units shall include, but not be limited to, the following:

1) Unit designation on Drawings.
2) Manufacturer model number.
3) Serial number.
4) Network address, if applicable.
5) Each equipment setting.
6) Mounting, supports, and restraints properly installed.
7) Proper service clearance provided.
8) Wiring and power connections correct.
9) Line-voltage reading(s) within acceptable range.
10) Wiring and controls connections correct.
11) Low-voltage reading(s) within an acceptable range.
12) Controller type and model controlling unit.
13) Controller location.
14) Temperature settings and readings within an acceptable range.
15) Condensate removal acceptable.
16) Noise level within an acceptable range.
17) Refrigerant piping properly connected and insulated.
18) Hydronic piping properly connected and insulated.
19) Proof of water flow checked for proper operation.
20) Condensate drain piping properly connected and insulated.
21) If applicable, external interlocks properly connected.
22) Remarks.

i. Installer shall provide manufacturer with the requested documentation and technical support during inspection.
j. Installer shall correct observed deficiencies found by the inspection.
k. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.
l. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.
m. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig (4137 kPa), using dry nitrogen.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
4. Prepare test report to record the following information for each test:

    a. Name of person starting test, company name, phone number, and e-mail address.
    b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.
    c. Detailed description of extent of tubing tested.
    d. Date and time at start of test.
    e. Test pressure at start of test.
    f. Outdoor temperature at start of test.
    g. Name of person ending test, company name, phone number, and e-mail address.
    h. Date and time at end of test.
    i. Test pressure at end of test.
    j. Outdoor temperature at end of test.
    k. Remarks:

5. Submit test reports for Project record.
6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
3. System refrigerant charging shall be witnessed by system manufacturer's representative.
4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be an employee or a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
2. Complete startup service of each separate system.
3. Complete system startup service according to manufacturer's written instructions.

B. Startup checks shall include, but not be limited to, the following:

1. Check control communications of equipment and each operating component in system(s).
2. Check each indoor unit's response to demand for cooling and heating.
3. Check each indoor unit's response to changes in airflow settings.
4. Check each indoor unit, HRCU, and outdoor unit for proper condensate removal.
5. Check sound levels of each indoor and outdoor unit.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.
2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.
3. Manufacturer shall electronically record not less than two 2 hours of continuous operation of each system and submit with report for historical reference.

a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Owner and Commissioning Agent to witness startup service procedures.
2. Provide written notice not less than 20 business days before start of startup service.

3.10 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two 2 visits to Project during other-than-normal occupancy hours for this purpose.

3.11 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.12 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of system Installer who are manufacturer's authorized service representative. Include two 2 service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.13 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two 2 years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.14 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's employed training instructor or factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.
2. Instructor's credentials shall be submitted for review by Architect Commissioning Agent Owner before scheduling training.
3. Instructor(s) primary job responsibility shall be Owner training.
4. Instructor(s) shall have not less than three 3 years of training experience with VRF HVAC system manufacturer and past training experience on at least three 3 projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.
2. Training shall occur before Owner occupancy.
3. Training shall be held at mutually agreed date and time during normal business hours.
4. Each training day shall not exceed eight 8 hours of training. Daily training schedule shall allow time for one 1-hour lunch period and 15 -minute break after every two 2 hours of training.
5. Perform not less than eight 8 total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume three 3 people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Architect or Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION 238130

SECTION 238216.11 - HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic air coils.
2. Integral face-and-bypass hot-water coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."

B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 200 psig/300 deg F.

D. Select cooling coils for no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

2.2 HYDRONIC AIR COILS

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

1. Aerofin.
2. Modine Commercial and Industrial Solutions.
3. Trane.
4. USA Coil & Air.

B. Source Limitations: Obtain hydronic coils from single source from single manufacturer.

C. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid.

D. Tubes:

1. Material: Copper.
2. Nominal Diameter: Minimum 1/2 inch or 5/8 inch (16 mm) before expanding, selected to provide performance indicated.
3. Nominal Wall Thickness: As required by performance, minimum 0.035 inch thick.
4. Return Bends: 180-degree bends; material and nominal diameter to match tubes.
5. Fluid Velocity at Design Flow Rate:

a. Maximum: 6 fps.
b. Minimum: 3 fps.

6. Features: Cleanable Individually drainable.

E. Fins:

1. Type: Plate.
2. Materials:

   a. Aluminum: 0.0060 inch (0.15 mm) thick.
   b. Copper: 0.0060 inch (0.15 mm) thick.

3. Spacing: Maximum 12 fins per inch.
4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
5. Configuration: Fin type as required by performance requirements.

F. Headers:

1. Material: Carbon steel Copper, removable for cleaning and inspection of tubes.
2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced-header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
4. Drains: Include low point of header with a NPS 1/2 (DN 13) drain connection.
5. Vents: Include high point of header with a NPS 1/2 (DN 13) vent connection.
6. Supply and Return Connections: Copper Carbon steel pipe; threaded or flanged, same end of coil.
7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.
8. Fluid Velocity at Design Flow Rate: Maximum of 6 fps (1.8 m/s).

G. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.

H. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 or Type 316 stainless steel.

I. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:

1. Manufacturer name, address, telephone number, and website address.
2. Manufacturer model number.
3. Serial number.

4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. Coil fin length.
7. Coil fin height.
8. Coil weight with fluid/without fluid.
9. Coil casing material and thickness.
10. Coil fin material and thickness.
11. Coil tube material and thickness.
12. Coil header material and thickness.

J. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating. See Drawings for coils requiring a corrosion-resistant coating.

K. Coating: Corrosion resistant.

2.3 MATERIALS

A. Aluminum: ASTM B209.

B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.

C. Copper Sheet: ASTM B152.

D. 90/10 Cupronickel Alloy: ASTM B122/ASTM B122M.

E. Steel:

1. Pipe Connections: ASTM A53/A53M.

F. Corrosion-Resistant Coating: Where indicated on Drawings, coat coils with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test in accordance with ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in. lb.
c. ASTM D3359 for cross-hatch adhesion of 5B.

2. Application: Spray.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.

B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

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

3.2 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.

D. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

E. Straighten bent fins on air coils.

F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.

END OF SECTION 238216.11

SECTION 238236 - FINNED-TUBE RADIATION HEATERS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

A. Section includes hydronic, finned-tube radiation heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details and dimensions of custom-fabricated enclosures.
4. Indicate location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
2. Method of attaching finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS

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

1. Slant/Fin Corp.
2. Sterling HVAC Products; a Mestek company.
3. Zehnder-Rittling.

B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

D. Front Panel: Minimum 0.0528-inch- Insert thickness thick steel.

E. Wall-Mounted Back Panel: Minimum 0.0329-inch- thick steel, full height, with full-length channel support for front panel without exposed fasteners.

F. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounted back panel shall be solid panel matching front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

G. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

H. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

I. Damper: Knob-operated internal damper at enclosure outlet.

J. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Color: Anodized finish, color as selected by architect from manufacturer's standard colors.

L. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 BASEBOARD RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.3 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of access door provided in enclosure.

H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.4 FIELD QUALITY CONTROL

A. Perform the following field 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.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238236

SECTION 238239.13 - CABINET UNIT HEATERS

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 cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include location and size of each field connection.
4. Include details of anchorages and attachments to structure and to supported equipment.
5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
6. Indicate location and arrangement of piping valves and specialties.
7. Indicate location and arrangement of integral controls.
8. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which cabinet unit heaters will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. .

6. Perimeter moldings for exposed or partially exposed cabinets.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Airtherm; a Mestek company.
2. QMark; Marley Engineered Products.
3. Trane.

2.2 DESCRIPTION

A. Factory-assembled and -tested unit complying with AHRI 440.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 CABINETS

A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch- thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch- thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessed Flanges: Steel, finished to match cabinet.

4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch- wide piping end pocket.
7. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.

2.5 FILTERS

A. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.

B. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.

C. Material: Pleated cotton-polyester media, MERV 8.

2.6 COILS

A. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

B. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

2.7 CONTROLS

A. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

B. Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Suspend cabinet unit heaters from structure with elastomeric hangers.

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors.

D. Comply with safety requirements in UL 1995.

3.4 FIELD QUALITY CONTROL

A. 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. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 238239.13

SECTION 250923 - BUILDING AUTOMATION SYSTEM (BMS) FOR HVAC

PART 1 - GENERAL

1.1 CONTROL SYSTEM DESCRIPTION

A. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.

B. The BAS shall meet BACnet communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects.

C. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.

D. Direct Digital Control (DDC) technology shall be used to facilitate the functions necessary for control of mechanical systems and equipment on this project.

1.2 CONNECTION TO EXISTING BMS SYSTEM

A. All new control equipment inclusive of digital controllers must communicate and integrate seamlessly with the existing BMS system by:
   1. Energy Management of Facilities, Inc. (EMF)

B. Connect all new controllers to the existing host computer and extend network, including software, as required for a fully integrated control system.

C. Modify and add programming in host computer as necessary to accept all new equipment, control points, sequence of operations, etc.

1.3 CODES AND STANDARDS

A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.

   1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.

   2. National Electrical Code - NFPA 70.

   3. Federal Communications Commission - Part J.

4. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification to improve interoperability with various building system manufacturers' control systems and devices.
5. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification to improve interoperability with various building system manufacturers' control systems and devices.

1.4 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.
   a. Table 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±1.0°C [±2°F]
Outside Air	±1.0°C [±2°F]
Water Temperature	±0.5°C [±1°F]
Delta –T	±0.15°C[±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading *Note 1
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)
Note 2: for both absolute and differential pressure
Note 3: * not including utility supplied meters

1.5 SUBMITTAL REQUIREMENTS

A. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.

B. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.

C. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.

D. All manufacturers' technical cut sheets for major system components.

E. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements

F. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.

G. Points list showing all system objects and the proposed English language object names.

H. Sequence of operation for each controlled mechanical system and terminal end devices.

I. BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.

J. BAS Workstation and HMI interface screen graphics for all systems, showing system schematics, control and instrumentation points, monitoring data, setpoints with adjustments, and alarms. A

K. Additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.

L. As-built drawings showing any and all modifications to the shop drawings that took place during the construction process.

1.6 WARRANTY REQUIREMENTS

A. Warrant all work as follows:

1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).

2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

1.7 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).

1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:

a. System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.
b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.
c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
d. Database back-up
e. Operator coaching

2. Technician shall review critical alarm log and advise of additional services that may be required.
3. Technician shall submit a written report after each inspection.

1.8 OWNERSHIP OF BAS MATERIAL

A. Project specific software and documantation shall become the owner's property upon project completion. This includes the following:
1. Operator Graphic files
2. As-built hardware design drawings
3. Operating & Maintenance Manuals
4. BAS System software database
5. Controller application programming databases
6. Application Specific Controller configuration files
7. Required Licensed software

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner or the owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

A. A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.

C. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall meet the ASHRAE 135 Standard either via BACnet MS/TP or BACnet over Zigbee.

1. Wireless Equipment Level Controller Communication and Auxiliary Control Devices shall conform to:
    a. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers on a certified, open standard wireless solution to enable integration with other suppliers using the same open standard.
    b. Each communication interface shall be ZigBee certified as a BACnet tunneling device as allowed by the BACnet Standard and defined by the Zigbee Alliance.
    c. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
    d. The controls wireless network shall be capable of similar performance to a wired, equally quantified network by responding to controls requests within 10% timing comparison to facilitate a similar user experience for facility managers and occupants.
    e. The controls wireless network shall be secured using Advanced Encryption Standard AES-128 (FIPS Pub 197) and HMAC (FIPS Pub 198). A Trust Center will create a randomly generated 128-bit network security key for each ZigBee network.
    f. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
    g. Indoor design range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to minimize the need for repeaters and optimize network reliability.
    h. To maintain robust communication, self-healing, redundant mesh networking and two-way communications shall be used to optimize the wireless network reliability.

i. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.

j. Space/wall sensors shall be available with batteries with a typical life of 15 or more years to minimize maintenance costs or with power harvesting capabilities to minimize the need for batteries.

k. Space/wall sensors shall be available with temperature, relative humidity, occupancy, and CO_2 to support common HVAC controls applications.

l. Occupancy sensors shall have adequate range, sensing patterns, and number of sensors required for 100% coverage.

m. CO_2 sensors shall have a design life of 15 or more years, and include barometric pressure sensing and be self-calibrating to minimize maintenance expenses over the life of the sensor.

n. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

D. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.3 OPERATOR INTERFACE

A. Operator Web Interface shall conform to following:

1. System Security

a. Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.

b. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.

c. Each operator shall be allowed to change their user password.

d. The System Administrator shall be able to manage the security for all other users.

e. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

f. User logon/logoff attempts shall be recorded.

g. The system shall track and record all user log-in activity and all changes done at the enterprise level including who made the change, when, what was changed, pervious value and new value.

2. Customizable Navigation Tree
   a. The operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:
      1) Move and edit any of the nodes of the tree.
      2) Move entire groups to any area of the tree
      3) Change the name of any node in the tree
      4) Create custom nodes for any page in the web interface including: graphics, data log views, schedules, and dashboards
      5) Support navigation from multi-building to single building view
      6) Ability to create folders and assign and change hierarchy of nodes of the tree

3. Standard Equipment Pages
   a. The operator web interface shall include standard pages for all major equipment.
   b. These pages shall allow an operator to obtain information relevant to the operation of the equipment, including:
      1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
      2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
      3) Data Logs for the equipment without requiring a user to navigate to a Data Log page and perform a filter.

4. System Graphics Package
   a. The operator web interface shall be graphically based and shall include at least one 3-D color graphic per piece of equipment, graphics for each hydronic system, and graphics that summarize conditions on each floor of each building included in this contract.
   b. Graphics Package shall include at a minimum:
      1) 3-D Color Site Map (for multiple building campus projects) or 3-D Building Rendering (for single building projects)
      2) 3-D Color Custom Floor Plans
         a) Floor Plan Graphics to show accurate ductwork of system
         b) Toggle Switch to turn ductwork on/off per each floor plan
         c) Indicate thermal comfort on floor plan graphics using colors to represent zone temperature relative to zone set point
      3) 3-D Color Hydronic System Graphics with Animations
         a) Example Animation: Pump Flashing when On
      4) 3-D Color Major Equipment Graphics with Animations

a) Example Animation: Fan Spinning when On

5. Manual Control and Override
   a. Point Control – There shall be a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.
   b. Temporary Overrides - The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
6. Engineering Units
   a. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
7. Scheduling
   a. A user shall be able to perform the following tasks utilizing the operator web interface:
   b. Create a new schedule, defining the default values, events and membership.
   c. Create exceptions to a schedule for any given day.
   d. Apply an exception that spans a single day or multiple days.
   e. View a schedule by day, week and month.
   f. Exception schedules and holidays shall be shown clearly on the calendar.
   g. Modify the schedule events, members and exceptions.
   h. Create schedules and exceptions for multiple buildings
   i. Apply emergency schedule to multiple buildings
   j. Drag and drop scheduling editing
   k. Global schedule and exceptions across multiple buildings
8. Data Logs
   a. Data Logs Definition.
      1) The operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
   b. Data Log Viewer.
      1) The operator web interface shall allow Data Log data to be viewed and printed.
      2) The operator web interface shall allow a user to view Data Log data in a text-based format (time –stamp/value).
      3) The operator shall be able to view the data collected by a Data Log in a graphical chart in the operator web interface.
      4) Data Log viewing capabilities shall include the ability to show a minimum of five points on a chart.
      5) Each data point data line shall be displayed as a unique color.

6) Data points can be hidden on the display view by clicking on the point
7) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
8) The system shall have a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

c. Export Data Logs.
1) The Enterprise operator web interface shall allow a user to export Data Log data in CSV, xlsx or text format for use by other industry standard word processing and spreadsheet packages.

9. Alarm/Event Notification
a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
b. The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.
c. The system operator will have the option of setting specific times and days that that they will receive alarm notifications.
d. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator web interface.
1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in categories based on severity.
2) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.

10. User Change Log
a. The operator shall be able to view all logged user changes in the system from any operator web interface.
1) An operator shall be able to group user changes by: date, affected, date & affected, user, date & user, transaction type, date & transaction type, or sort only.
2) The operator will have the option of additional filtering capability of: date, transaction, type, user, affected, and details that can be used individually or in conjunction with other filters.

11. Reports
a. The operator web interface shall have a reporting package that allows the operator to select reports to run.
b. The operator web interface shall have the ability to schedule reports to run at specified intervals of time.
c. The Enterprise operator web interface shall have the ability to email schedule reports at specified intervals of time.

d. The following standard reports shall be available without requiring a user to manually design the report:
   1) All Points in Alarm Report: On demand report showing all current alarms.
   2) All Points in Override Report: On demand report showing all overrides in effect.
   3) Schedules Report: List of all weekly events for all schedules in selected buildings
   4) Space Comfort Analysis Report: List of spaces that meet selected criteria for potential comfort issues (temp variance, high, low, unoccupied)

12. Operator Web Interface must meet the following Agency Compliance:
    a. BACnet Testing Laboratory (BTL) Listed

2.4 MOBILE APP INTERFACE

A. Mobile App Operator Interface shall support the following Operating systems
   1. Apple iOS 6
   2. Apple iOS 7
   3. Apple iOS 8
   4. Android V2.3
   5. Android V4.3
   6. Android V4.4

B. The operator interface shall support system access on a mobile device via a mobile app to:
   1. Alarm log
   2. System Status
   3. Equipment status
   4. Space Status
   5. Standard Equipment graphics

C. The operator interface shall support actions on a mobile device via a mobile app to:
   1. Override set points
   2. Override occupancy
   3. Acknowledge Alarms
   4. Comment on Alarms

2.5 PROGRAMMING TOOLS

A. Custom Application Programming Tools to create, modify, and debug custom application programming, under license for a period of at least (1) year. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. Upon expiration of software license the building owner may choose to renew the license at their discretion.

B. Custom Graphic Editor. The tools neceesary to create, modify, and debug custom graphics. The operator shall be able to create, edit, and download custom graphics at the same time that all other system applications are operating. The system shall be fully operable while custom graphics are edited, compiled, and downloaded.

2.6 BUILDING CONTROLLERS

A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.

B. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.

C. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

D. All System Controllers shall have a real-time clock.

E. Data shall be shared between networked System Controllers.

F. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:

1. Assume a predetermined failure mode.
2. Generate an alarm notification.
3. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
4. Automatically reset the System Controller to return to a normal operating mode.

G. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40° C to 50° C [-40° F to 122° F].

H. Clock Synchronization.

1. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
2. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
3. All System Controllers shall automatically adjust for daylight savings time if applicable.

I. Serviceability

1. Diagnostic LEDs for power, communications, and processor

J. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.

K. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.7 ADVANCED APPLICATION CONTROLLERS

A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.

B. To meet the sequence of operation for each application, the Controller shall use programs by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

C. Stand-Alone Operation: In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.

D. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

E. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls by the equipment manufacturer must supply the required I/O for the equipment.

F. Input/Output Expandability – For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

G. Serviceability – The Controller shall have the following in order to improve serviceability of the Controller.

1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
2. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.
3. Controller data shall be maintained through a power failure.

H. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

I. Controller must meet the following Agency Compliance:

1. UL916 PAZX, Open Energy Management Equipment
2. UL94-5V, Flammability
3. FCC Part 15, Subpart B, Class B Limit
4. BACnet Testing Laboratory (BTL) Listed

2.8 APPLICATION-SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controller, The controller shall use programs by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.

B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.

C. Stand-Alone Operation: In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.

D. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.

E. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls by the equipment manufacture must supply the required I/O for the equipment.

F. Input/Output Expandability – For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.

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1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.

2. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.

3. Controller data shall be maintained through a power failure.

H. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.

I. Controller must meet the following Agency Compliance:

1. UL916 PAZX, Open Energy Management Equipment

2. UL94-5V, Flammability

3. FCC Part 15, Subpart B, Class B Limit

4. BACnet Testing Laboratory (BTL) Listed

2.9 FIELD HARDWARE/INSTRUMENTATION

A. Temperature Sensing Devices

1. Type & Accuracy. Temperature sensors shall be of the type and accuracy indicated for the application. Sensors shall have an accuracy rating within 1% of the intended use temperature range.

2. Outside Air Temperature Sensors. Outside air temperature sensors' accuracy shall be within +1degF in the range of -52degF to 152degF.

3. Room Temperature Sensors. Room temperature sensors shall have an accuracy of +0.36degF in the range of 32degF to 96degF.

4. Chilled Water and Condenser Water Sensors. Chilled water and condenser water sensors shall have an accuracy of +0.25degF in their range of application.

5. Hot Water Temperature Sensors. Hot water temperature sensors shall have an accuracy of +0.75degF over the range of their application.

B. Pressure Instruments

1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 MA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within +2% of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.
2. Pressure Switches: Pressure switches shall have a repetitive accuracy of +2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.

C. Flow Switches:

1. Flow switches shall have a repetitive accuracy of +1% of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.

D. Humidity Sensors:

1. Sensors shall have an accuracy of +2.5% over a range of 20% to 95% RH.

E. Current Sensing Relays

1. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.

F. Output Relays

1. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.

G. Solid State Relays

1. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20F-140F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression as an integral part of the relays.

H. Valve and Damper Actuators

1. Electronic Direct-Coupled: Electronic direct-coupled actuation.

2. Actuator Mounting: The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable
3. Electronic Overload Sensing: The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
4. Power Failure/Safety Applications: For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
5. Spring Return Actuators: All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
6. Proportional Actuators: Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
7. 24 Volts (AC/DC) actuators: All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
8. Non-Spring Return Actuators: All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
9. Modulating Actuators: All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
10. Conduit Fitting & Pre-Wiring: Actuators shall be have a conduit fitting and a minimum 3ft electrical cable, and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
11. U.L. Listing: Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.

12. Warranty: Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.
13. Controls valve actuator application fail-safe positions shall be as follows
    a. AHU coils: normally open
    b. Boilers: normally open
    c. Chiller evaporator: normally open
    d. Cooling tower isolation: normally open
    e. Chiller condenser: normally open
    f. Terminal equipment heating: normally open
    g. Terminal equipment cooling: normally closed
    h. Two-pipe changeover valves: fail to heating

I. Control Valves: Factory fabricated U.S. forged and assembled electric control valves of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. The valve size shall be in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, valves shall mate and match material of connecting piping. Equip control valves with control valve motor actuators, with proper shutoff rating for each individual application.

1. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, Class 150 at 250°F and maximum full flow pressure drop 5 psig. Globe type with replaceable plugs and seats of stainless steel or brass. Select operators to close valves against pump shutoff head.
2. Double Seated Valves: Balanced plug type, with caged type trim providing seating and guiding surfaces on “top and bottom” guided plugs.
3. Valve Trim and Stems: Polished stainless steel.
4. Packing: Spring-loaded teflon, self-adjusting.
5. Terminal Unit Control Valves: Unless indicated otherwise, modulating, electrically actuated (by 24VAC max) control ball valves shall control terminal units including, but not necessarily limited to, convectors, finned tube radiation, and fan coil units that are of integral motor type.

J. Pressure-Independent Control Valves:

1. Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall meet ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Valve leakage shall meet

FCI 70-2 Class IV leakage rating (0.01 percent of valve Kv). Valves shall be two-way pressure independent globe-style bodies.

a. Bodies for valves 2 inches and smaller shall be brass or bronze, with union ends
b. Bodies for valves 2 to 3 inches shall be of brass, bronze or iron.
c. Bodies for valves 2.5 inches and larger shall have flanged-end connections.
d. Valve and actuator combination shall be normally open or normally closed as shown.

2. Two-Way Pressure Independent Globe Valve: The valve shall be two-way globe style with integrated differential pressure control regulator. Where indicated modulating proportional valve application shall utilize controller or actuator to match required control signal to complement controlled coil heat transfer characteristic for linear control. The valve shall have:
   a. Integrated pressure regulator; regulator to control pressure across control valve orifice.
   b. Regulator incorporating EPDM diaphragm, stainless steel spring and pressure control disc. Pressure control seat shall be brass construction with vulcanized EPDM.
   c. Counterbalance of supply pipe pressure to return pipe pressure across diaphragm to prevent diaphragm damage when control valve is closed
   d. User adjustable maximum flow within valve control range; Adjustment method shall indicate percentage of valve flow range and utilize spring locked method of adjustment.
   e. The ability to regulate internal control valve differential pressure to have 100% control valve authority.
   f. shall have linear flow characteristic.
   g. Back seated globe design to allow service of packing under pressure without leakage.
   h. Entering to leaving (P1-P3) pressure control across low flow ½'' valve in size from 2.3PSI - 60PSI.
   i. Entering to leaving (P1-P3) pressure control across valves ½'' - ¾'' in size from 5PSI - 60PSI.
   j. Entering to leaving (P1-P3) pressure control across valves 1'' - 1¼'' in size from 5PSI - 60PSI.
   k. Entering to leaving (P1-P3) pressure control across valves 1½'' - 10'' in size from 4PSI - 60PSI.
   l. Union connections for ½'' - 2'' valve size: ANSI flanged connections for 2.5'' - 10'' valve sizes
   m. Stainless steel internal trim with brass globe and seat.

n. A Threaded actuator connection

o. Flow requirements sized for nominal body selection no more than one size smaller to corresponding nominal pipe connection.
   1) ½'' bodies shall be utilized for ½'' and may be utilized for ¾'' pipe connection and flow less than 5 GPM.
   2) ¾'' bodies may be utilized for ¾'' pipe and may be applied to 1'' pipe connection with flow less than 7.5 GPM.
   3) 1'' bodies may be utilized for 1'' pipe and may be applied to 1¼'' pipe connection with flow less than 12 GPM.
   4) 1¼'' bodies may be utilized for 1¼'' and may be applied to 1½'' pipe connection with flow less than 17.5 GPM.
   5) 1½'' bodies may be utilized for 1½'' pipe and may be applied to 2'' pipe connection with flows less than 33 GPM.
   6) Flows less than 55 GPM may use 2'' bodies.
   7) Flows less than 85 GPM may use 2½'' bodies.
   8) Flows less than 120 GPM may use 3'' bodies.
   9) Flows less than 165 GPM may use 4'' bodies.
   10) Flows less than 395 GPM may use 5'' bodies.
   11) Flows less than 640 GPM may use 6'' bodies.
   12) Flows less than 830 GPM may use 8'' bodies.
   13) Flows less than 1230 GPM may use 10'' bodies.

K. Dampers: Automatic control low leakage, opposed blade dampers, with damper frames not less than formed 13-gauged galvanized steel and mounting holes for enclosed duct mounting. Damper blades not less than formed 16-gauged galvanized steel, with maximum blade width of 8-inch. Equip dampers with motors of proper rating of each application.

1. Secure blades to ½ inch diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Blade bearings to be Nylon with thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.

2. Operating Temperature Range: From –20° to 200°F (-29° to 93°C).

3. For low leakage application or opposed blade design (as selected by manufacturers sizing techniques) with inflatable steel blade edging or replaceable rubber seals, rated for leakage less than 4 cfm per square foot of damper area, AR differential pressure of 4-inch w.g. when damper is being held by torque 50 inch-pounds.

4. Outdoor air and exhaust air dampers shall be low leakage and thermally insulated.

L. Electromagnetic Flow Meters

1. complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1. Output signals shall be completely isolated and shall consist of the following: (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable, (1) scalable dry contact output for totalization, and (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter. Each flow meter shall be covered by the manufacturer's two-year warranty.
2. Optional Flow Display: D-100 Series Display Module for network interface and local/remote indication of flow rate and total.

M. Ultrasonic Flow Meters: Provide a clamp-on transit time ultrasonic flowmeter complete with matched transducers, self- aligning installation hardware and triaxial transducer cables and calibration certificate

1. Flowmeter shall consist of a processor / transmitter, matched pair of transducers and mounting hardware including pipe clamps and mounting bracket for the line size and material specified

    a. Sensing Technology: Ultrasonic transit time velocity-measurement utilizing non-wetted transducers matched for the specific applications in terms of pipe size and pipe material

    b. Enclosure: Wall mount, NEMA4X polycarbonate with clear shatterproof enclosure

    c. Maximum Temperature Rating: 250 deg F

    d. Meter shall have CE approval

    e. Each flowmeter shall be covered by the manufacturer's two-year warranty

2. Operation and Configuration

    a. Flow Range: Flow-measuring element and transmitter shall cover operating range of equipment or system served.

    b. Accuracy: Flowmeter shall have calibrated outputs directly from the transmitter, throughout the operating range with plus or minus 1.0% of flow rate from 1 to 20 ft/sec velocity

c. Calibration: ach flow meter shall be individually calibrated against a N.I.S.T. traceable standard and receive a certificate of calibration. Each flow meter shall be factory programmed based on the application data specified at time of order.

d. Transmitter and Display: Operator interface consisting of five pushbuttons. Display shall visually indicate instantaneous flow rate and total fluid volume. Output signals shall be RS485 serial network protocol, BACnet MS/TP or MODBUS RTU, native to the transmitter, two (2) programmable pulse outputs configured for totalizing pulse, flow direction or flow alarm indication and one (1) analog output signal.

e. Flow meter shall be capable of operating from 24V ac/dc or 120V ac mains power.

PART 3 - EXECUTION

3.1 COORDINATION

A. Power is to be sourced from existing electrical distribution system as necessary for the controls system. Must comply with the National Electrical Code.

B. Test and Balance

1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.

2. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.

3.2 INSTALLATION

A. Connect and configure equipment and software to achieve sequences of operations specified

B. Verify location of exposed control sensors with arhitect prior to installation. Install devices 48 inches above the floor, or lower if necessary.

C. Install damper moters on outside of duct in warm areas, not tin locations exposed to outdoor temperatures.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used if the following conditions are met:

1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).

B. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.

C. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m (10 ft.) intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 1.5 m (5 ft.) intervals or more often to achieve a neat and workmanlike result.

D. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, use step-down transformers to achieve the desired control voltages.

E. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.

F. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment

G. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.

H. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.

I. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.

J. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

K. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties.
3. Test each point through its full operating range to verify that safety and operating control setpoints are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:
    a. a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    b. b. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration: A complete demonstration of the capabilities of the BAS system shall be performed by the BAS manufacturer’s field personnel. The BAS manufacturer shall dedicate a minimum of (16) hours on-site with the Owner representatives, and Engineer to

demonstrate a complete functional test of all the BAS system requirements. This BAS demonstration shall constitute an acceptance inspection, and will represent the process of approving the BAS as designed and specified. Functional testing shall include, but is not limited to, the following system level components where installed:

B. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative.

3.6 TRAINING

A. Two training sessions of four (4) hours minimum per session, with sessions on separate days for the facility maintenance staff. The training shall review accessing the web based building automation system (BAS) by password, show how to navigate through each of the system's graphic screens to identify each of the parameters which are just monitored and what parameters can be adjusted (setpoints and schedules), review each of the alarms which can be sent to the BAS and how the maintenance staff should address each, and proper logging out of the system.

1. Review with the maintenance staff current setpoints and instruct them how to adjust the setpoints. Instruct the staff in how to adjust equipment schedules and assist them in setting up each applicable schedule.
2. Instruct the staff in system troubleshooting. Instruct them in setup of trending / data logging and how to review the resulting data.
3. Instruct the staff how to do seasonal system startups and shutdowns.
4. Perform a walk-through of the building and review the location of room sensors and unit controllers.

END OF SECTION 250923

SECTION 250993 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes control sequences for direct digital controls for HVAC systems, subsystems, and equipment.

1.2 ACTION SUBMITTALS

A. Product Data:
   1. An instrumentation points list for each controlled system. Label each element of the controlled system in table format. Show, in the table:
      a. Point Number
      b. Point Tag
      c. Description
      d. Manufacturer and Model Number
      e. System
      f. Equipment
      g. Instrument Tag
      h. Loop Number
      i. Control Function Matrix identifying: Binary In (BI), Analog In (AI), Binary Out (BO), Analog Out (AO)
      j. Ethernet Communication
      k. Hardware Installation Matrix identifying: Original Equipment Manufacturer (OEM) provided, Field Installed, Existing Device
      l. PLC or direct digital control panel ID
   2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:
   1. Riser diagrams showing control network layout, communication protocol, and wire types.
   2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
   3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.3 GENERAL

A. Setpoints and schedules described in the operation of building systems are operator adjustable unless otherwise indicated.

B. Provide digital input from fire alarm system to indicate activation of system. Coordinate interface with the electrical contractor.

C. Data Logging: The building automation system trends all monitored values within a period of 1 year. The frequency of recording is adjustable from every 1 minute to 1 hour. The trends can be printed in the Microsoft Excel format with clearly defined headings.

D. Global Point Summary:
   a. Outdoor air temperature - AI
   b. Outdoor air dewpoint Temperature - AI
   c. Fire Alarm Status - BI

E. Hardwired Safeties (always enabled)
   1. When provided, the duct smoke detectors shall shutdown the supply and exhaust fans on a smoke condition through the fire alarm system. The unit shutdown wiring from the fire alarm system output module to the variable frequency drive shutdown circuit shall be provided and installed by fire alarm contractor. The fire alarm system shall notify the building automation system to restore normal controls upon deactivation of fire alarm condition.
   2. The building automation system shall shutdown the supply and exhaust fans upon abnormal current detected by the variable frequency drives and raise critical alarm.

F. Freeze Protection
   1. When any freezestat detects the temperature drops below 45°F (adjustable), the control valve will open 100% and when it drops below 40°F (adjustable), mixed air dampers shall be in the 100% return air position.

G. Space temperature setpoints
   1. Cooling: 75°F (adjustable)
   2. Heating: 70°F (adjustable)
   3. Maintain 5° dead band between heating and cooling setpoints for all systems.

H. Points for all equipment:
   1. Air Filter Timer: For all filters without differential pressure sensors, fan run compare fan run time to a filter maintenance timer setpoint which will notify the BAS at a user definable duration.
   2. Alarms:
      a. Variable frequency drive fault.
      b. Fan failure: Commanded ON, but the status is OFF.

c. Fan running in hand: commanded OFF, but the status is ON.

d. Activation of the freezestat.

I. Morning Start Up:

1. For all equipment, when space temperature reaches occupied space heating/cooling temperature setpoint, the system switches to occupied mode operation. Provide optimal start algorithm for morning warm-up mode to minimize warm-up period while achieving comfort conditions by the start of the scheduled occupied period.

1.4 TYPICAL ENERGY RECOVER VENTILATOR / VRF SYSTEM

A. System Components

1. Energy recovery ventilator.
   a. Supply fan, constant volume with variable frequency drive for automatic balancing and outdoor air damper, 2-position.
   b. Exhaust fan, constant volume with variable frequency drive for automatic balancing and exhaust air damper 2-position.
   c. Heating hot water (glycol) coil control valve, modulating.
2. VRF compressor, modulating.
3. VRF Indoor split units.
   a. Supply fan, modulating.
   b. DX, modulating.

B. System Description

1. A core style energy recover ventilator on the roof provides ventilation and exhaust. Ducted heating coils provide heating of ventilation air. The VRF (variable refrigerant flow) system, which is comprised of indoor split units, and roof mounted condensing units provide (optional) heating and cooling through the unit's factory provided, internal controls.

C. System Off

1. Energy recovery ventilator:
   a. Supply fan is off and outdoor air damper is closed.
   b. Exhaust fan is off and exhaust air damper is closed.
   c. Heating hot water (glycol) coil control valve is closed.
2. VRF compressor is off.
3. VRF Indoor split units:
   a. Supply fan is off.
   b. DX is off.

D. Start-Up:

1. Energy recovery ventilator:
    a. Supply fan is on, and outdoor air damper is open.
    b. Exhaust fan is on, and exhaust air damper is open.
    c. Heating hot water (glycol) coil control valve is 100% open in heating mode, otherwise it is closed.
2. VRF compressor is on for cooling mode, otherwise it is off.
3. VRF Indoor split units:
    a. Supply fan is on.
    b. DX is on for cooling mode, otherwise it is off.

E. Occupied Mode
1. Energy recovery ventilator:
    a. Supply fan is on, and outdoor air damper is open.
    b. Exhaust fan is on, and exhaust air damper is open.
    c. Heating hot water (glycol) coil control valve modulates to maintain discharge air temperature set point in heating mode otherwise it is closed
        1) When the outdoor air temperature is at or below 40°F discharge air is 95°F and when it is above 40°F discharge air is 75°F (adjustable).
2. VRF compressor is on in cooling mode, otherwise it is off.
3. VRF Indoor split units:
    a. Supply fan modulates to maintain space temperature set point.
    b. DX modulates to maintain space temperature set point in cooling mode, otherwise it is off.

F. Unoccupied Mode:
1. Energy recovery ventilator:
    a. Supply fan is off and outdoor air damper is closed.
    b. Exhaust fan is off and exhaust air damper is closed.
    c. Heating hot water (glycol) coil control valve is 100% open in heating mode, otherwise it is closed.
2. VRF system cycles to maintain unoccupied space temperature set point in cooling mode, otherwise it is off.

1.5 CAFETERIA & KITCHEN

A. Main System Components
1. Energy Recovery Unit
    a. Outdoor air damper, 2-position.
    b. Supply fan, constant volume with VFD for automatic balancing.

c. DX Cooling.
d. Recirculation air damper, modulating.
e. Energy recovery wheel, modulating.
f. Exhaust fan, modulating and exhaust air damper, 2-position.
g. Glycol heating hot water coil control valve, modulating.

2. Kitchen hood exhaust fan, constant speed with variable frequency drive for balancing.
3. Kitchen general exhaust fan, constant speed and exhaust air damper, 2 position.
4. Cabinet Unit Heater:
   a. Supply fan, constant speed.
   b. Heating hot water coil control valve, modulating.

B. System Description:
1. A roof mounted energy recovery unit provides cooling, heating, ventilation, and exhaust to the cafeteria. Transfer air is provided to the kitchen and exhausted through either the general exhaust fan or kitchen hood and a cabinet heater provides heating.
   a. ALTERNATE #3:
      1) Accepted: Provide sequence as written.
      2) No Accepted:
         a) ERU will serve the cafetorium only.
         b) F-C shall modulate with the OA on the existing unit serving room 152.

C. System Off:
1. Energy Recovery Unit:
   a. Outdoor air damper is closed.
   b. Supply fan is off.
   c. Recirculation air damper is 100% open.
   d. DX is off.
   e. Energy recovery wheel is off.
   f. Exhaust fan is off and exhaust air damper is closed.
   g. Heating hot water (glycol) coil control valve is closed.
2. Kitchen hood exhaust fan is off and damper is closed.
3. Kitchen general exhaust fan is off.
4. Cabinet Unit Heater:
   a. Supply fan is off.
   b. Heating hot water coil control valve is closed.

D. Start-Up
1. Energy Recovery Unit:

a. Outdoor air damper is closed.
b. Supply fan is on.
c. Recirculation air damper is open.
d. DX is on for cooling mode, otherwise it is off.
e. Energy recovery wheel is off.
f. Exhaust fan is off and exhaust air damper is closed.
g. Heating hot water (glycol) coil control valve is 100% open in heating mode, otherwise it is closed.

2. Kitchen hood exhaust fan is off.
3. Kitchen general exhaust fan is off and damper is closed
4. Cabinet Unit Heater:
   a. Supply fan is on in heating mode, otherwise it is off.
   b. Heating hot water coil control valve is 100% open in heating mode, otherwise it is closed.

E. Occupied Mode
1. Energy Recovery Unit:
   a. Outdoor air damper is open.
   b. Supply fan is on.
   c. Recirculation air damper is open to provide minimum volumetric flow rate of outdoor air as scheduled unless space temperature rises above space cooling temperature setpoint and outdoor air temperature is less than space temperature (economizer mode), then the return air damper modulates to increase outdoor air as required to maintain space cooling temperature setpoint. Provide low-limit override to prevent discharge air temperature from dropping below low limit setpoint (default = 55°F) by modulating the mixed air damper to decrease the outdoor air without dropping below the minimum scheduled value.
   d. DX modulates to maintain occupied space temperature setpoint in cooling mode, otherwise it is off.
   e. Energy recovery wheel is on unless in economizer mode, then the wheel is off.
   f. Exhaust fan modulates to match the outdoor air quantity as listed below, measured by the air flow measuring station, and exhaust air damper is open.
      1) Kitchen hood fan off, general kitchen fan on: 4000cfm
      2) Kitchen hood fan on, general kitchen fan off: 1500cfm
   g. Heating hot water (glycol) coil control valve modulates to maintain occupied space temperature setpoint.
2. Kitchen hood exhaust fan is off unless it is commanded on.
3. General exhaust fan is on unless kitchen hood is commanded on then it is off.
4. Cabinet Unit Heater:

a. Supply fan is on in heating mode, otherwise it is off.
b. Heating hot water coil control valve modulates to maintain occupied space temperature setpoint in heating mode, otherwise it is closed.

F. Unoccupied Mode
1. Energy Recovery Unit:
a. Outdoor air damper is closed.
b. Supply fan cycles to maintain unoccupied temperature sent point.
c. Recirculatin air damper is 100% open.
d. DX is on for cooling mode, otherwise it is off.
e. Energy recovery wheel is off.
f. Exhaust fan is off, and exhaust air damper is closed.
g. Heating hot water (glycol) coil control valve is 100% open in heating mode, otherwise it is off.
2. Kitchen hood exhaust fan is off unless it is commanded on.
3. General exhaust fan is off.
4. Cabinet Unit Heater:
a. Supply fan is on in heating mode, otherwise it is off.
b. Heating hot water coil control valve modulates to maintain occupied space temperature setpoint in heating mode, otherwise it is closed.

1.6 SECURE VESTIBULE 142A

A. System Components:
1. Cabinet Unit Heater:
a. Supply fan, constant speed.
b. Heating hot water coil control valve, modulating.

B. System Description:
1. Cabinet heaters provide heating.

C. System Off
1. Cabinet Unit Heater:
a. Supply fan is off.
b. Heating hot water coil control valve is closed.

D. Start-Up
1. Cabinet Unit Heater:
a. Supply fan is on in heating mode, otherwise it is off.

b. Heating hot water coil control valve is 100% open in heating mode, otherwise it is closed.

E. Occupied Mode
1. Cabinet Unit Heater:
a. Supply fan is on in heating mode, otherwise it is off.
b. Heating hot water coil control valve modulates to maintain occupied space temperature setpoint in heating mode, otherwise it is closed.

F. Unoccupied Mode:
1. Cabinet Unit Heater:
a. Supply fan cycles.
b. Heating hot water coil control valve is 100% open in heating mode, otherwise it is closed.

1.7 TYPICAL FINNED TUBE

A. System Components
1. Finned tube control valve, modulating.

B. System Description
1. Finned tube provides heat.

C. System Off
1. Finned tube control valve is closed.

D. Start-Up:
1. Finned tube control valve is 100% open in heating mode, otherwise it is closed.

E. Occupied Mode
1. Finned tube control valve modulates to maintain occupied space temperature set point in heating mode, otherwise it is closed.

F. Unoccupied Mode
1. Finned tube control valve modulates to maintain unoccupied space temperature set point in heating mode, otherwise it is closed.

1.8 END OF SECTION 230993

SECTION 260500 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY

A. The General and Supplementary Conditions are a part of the requirements for the work under this Division of the Specifications.

1.2 WORK INCLUDED

A. Provide labor and materials required to install, test and place into operation the electrical systems as called for in the Contract Documents, and in accordance with applicable codes and regulations.

B. Provide labor, materials, and accessories required to provide complete, operating electrical systems. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating electrical systems shall be provided without additional cost to the Owner.

1.3 QUALITY ASSURANCE

A. Comply with the current applicable codes, ordinances, and regulations of the Authority or Authorities Having Jurisdiction, the rules, regulations and requirements of the utility companies serving the project, and the Owner's insurance underwriter.

B. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.

C. Should any change in drawings or specifications be required to comply with governing regulations, notify the Engineer prior to submitting bid.

D. All electrical equipment, materials, devices and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, IES, NEC, NEMA, NETA, NFPA, OSHA, SMACNA, UL, and the State Fire Marshal.

E. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workperson-like manner by competent workpeople. Provide a competent, experienced, full-time Superintendent who is authorized to make decisions on behalf of the Contractor.

F. Equipment shall be certified for use in the state of New York and shall meet the New York State energy code.

1.4 ABBREVIATIONS AND DEFINITIONS

A. Abbreviations:

1.	ADA	Americans with Disabilities Act
2.	ANSI	American National Standards Institute
3.	ASTM	American Society for Testing and Materials
4.	BIL	Basic Impulse Level
5.	CBM	Certified Ballast Manufacturers
6.	EIA	Electronic Industries Alliance
7.	ETL	Electrical Testing Laboratories, Inc.
8.	FM	Factory Mutual
9.	IEEE	Institute of Electrical and Electronic Engineers
10.	IES	Illuminating Engineering Society
11.	IPCEA	International Power Cable Engineers Association
12.	LED	Light Emitting Diode
13.	NEC	National Electric Code
14.	NEMA	National Electrical Manufacturers Association
15.	NETA	National Electrical Testing Association
16.	NFPA	National Fire Protection Association
17.	OEM	Original Equipment Manufacturer
18.	OSHA	Occupational Safety and Health Administration
19.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
20.	TIA	Telecommunications Industry Association
21.	UL	Underwriters Laboratories Inc.

B. Definitions:

1. Where it is stated in these specifications to submit to Engineer for review, refer to Architectural General and Supplementary Conditions for proper procedures.
2. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.
3. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation.
4. PROVIDE means to FURNISH and INSTALL.
5. AS DIRECTED means as directed by the Engineer, or the Engineer's Representative.

6. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
7. SUBMIT means submit to Engineer for review.

1.5 GUARANTEE

A. Submit a single guarantee stating that the work is in accordance with the Contract Documents. Guarantee work against faulty and improper material and workmanship for a period of one year from the date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are provided or specified herein, the longer term shall apply. Manufacturer's warranty/guarantee on equipment shall be begin at time of equipment startup not upon receipt of equipment. Correct any deficiencies, which occur during the guarantee period, within 24 hours of notification, without additional cost to the Owner, to the satisfaction of the Owner. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.

1.6 USE OF THE ARCHITECT'S AND ENGINEER'S DRAWINGS

A. The Contractor shall obtain, at the Contractor's expense, from the Architect or Engineer a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Architect and Engineer a written release of liability acceptable to the Architect and Engineer prior to receiving the electronic media.

PART 2 – PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

B. Products and materials shall not contain asbestos, PCB, or any other material that is considered hazardous by the Environmental Protection Agency or any other Authority Having Jurisdiction.

C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Architect or Engineer at no additional cost to the Owner.

D. Provide name/data plates on major components of equipment with manufacturer's name, model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.

E. Install materials and equipment with qualified trades people.

F. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

G. Fully lubricate equipment where required.

H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.

I. Where factory testing of equipment is required to ascertain performance, and attendance by the Owner's Representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.

J. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.

K. Enclosures for electrical equipment installed in mechanical and electrical equipment rooms shall be NEMA type 1 gasketed. Enclosures for electrical equipment installed outdoors shall be NEMA type 3R unless otherwise noted.

L. Energy consuming equipment shall be certified for use in the state of New York and shall meet the New York State Energy Code and local energy ordinances.

2.2 SUBSTITUTIONS

A. Contract Documents are based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as, stated or implied in the Contract Documents.

B. Submit proposals to provide substitute materials or equipment, in writing, with sufficient lead time for review prior to the date equipment must be ordered to maintain project schedule. Reimburse Owner for costs associated with the review of the proposed substitution whether substitution is accepted or rejected.

C. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work and related trades are not permitted.

D. The proposed substitution shall conform to the size, ratings, and operating characteristics of the equipment or systems as specified and shown on the Drawings.

E. Proposals for substitutions shall include the following information:

1. A description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades.
2. Schematic drawings and details.
3. List of revisions to the Contract Documents that must be made if the substitution is accepted.
4. Estimate of costs the Owner may incur in implementing the substitution, such as test, evaluation, operating and support costs.
5. Statement of the time by which a Contract modification accepting the substitution must be issued, noting any effect on the Contract completion time or the delivery schedule.
6. A statement indicating the reduction to the Contract price if the Owner accepts the substitution. Include required modifications to all related trades.

PART 3 – EXECUTION

3.1 FEES AND PERMITS

A. Pay all required fees/charges and obtain all required permits related to the electrical installation. Coordinate with the local electric utility company and the local telecommunications company as to their requirements for service connections and provide all necessary payments for associated engineering/field services.

B. Pay royalties or fees in connection with the use of patented devices and systems.

C. Provide an electrical inspection for all related electrical work by a qualified New York State electrical inspection agency. The inspection shall be performed, in the presence of the engineer or architect of record. An electrical approval certificate shall be issued by the electrical inspection agency.

3.2 SUBMITTALS AND REVIEWS

A. Submit shop drawings, manufacturer's product data sheets, samples, and test reports as specified.

B. After execution of Owner/Contractor Agreement, submit a complete typed list of all electrical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.

C. After execution of Owner/Contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or Drawing number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned submittal identification number.

D. After the Contract is awarded, obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all subcontractors, for all materials and equipment as specified. Submit data and details of such materials and equipment for review. Prior to submission, certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work, which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.

E. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments shall not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.

F. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.

G. A minimum period of ten working days, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. This time period must be considered by the Contractor in the scheduling of the work.

H. Submit electronic copies, preferably in PDF format, of all items requiring shop drawings.

I. Submit materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalog material. Maintenance and operating manuals are not acceptable substitutes for shop drawings.

J. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finishes.

K. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, conduit, outlet-type and service connection data; motor sizes complete with voltage ratings and schedules.

L. Maintain a complete set of reviewed and stamped shop drawings and product data on site.

M. Prepare and submit detailed shop drawings for major electrical and telecommunications conduit duct banks and other distribution services in 3/8″ = 1′-0″ sale, include locations and sizes of openings in floor decks, walls and roofs.

N. For each room or area of the building containing electrical equipment, submit the following:

1. Floor Plans: Plan and elevation layout drawings indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 inch to 1 foot. They shall be prepared in the following manner:
    a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
    b. Illustrate all electrical equipment proposed to be contained therein. Include top and bottom elevations of all electrical equipment. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
    c. Illustrate all other equipment therein such as conduits, detectors, luminaries, ducts, registers, pull boxes, wireways, structural elements, etc.
    d. Indicate the operating weight of each piece of equipment.
    e. Indicate the heat release from each piece of electrical equipment in terms of BTU per hour. This information shall be that which is supplied by the respective manufacturers.
    f. Illustrate concrete pads, curbs, etc.
    g. Indicate dimensions to confirm compliance with code-required clearances.

h. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).
i. Equipment removal routes.
j. Any exterior wall or foundation penetrations.

O. All shop drawings shall be prepared using AutoCAD software. Hand drawn shop drawings will not be accepted.

P. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.

Q. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superceded in any way by the review of shop drawings, product data and samples.

R. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

3.3 COORDINATION OF WORK

A. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.

B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.

C. The electrical drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.

D. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to

such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.

E. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations accepted by the Engineer before proceeding with the installation.

F. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.

G. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings prior to installation.

H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in electrical panels. Show the actual circuit numbers on the as-built Record Drawings and on the associated typed panelboard directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the Drawings and/or as directed.

I. The Drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams (if any), the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC. All power branch circuits shall be equipped with a ground conductor.

J. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.

K. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote LED Drivers, pull boxes, etc.) requiring access in order that the ceiling trade will know where to install access doors and panels.

L. Consult with other trades regarding equipment so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.

M. Furnish and set sleeves for passage of conduits through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each conduit passing through building surfaces.

N. Provide firestopping around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions and floors.

O. Provide detailed information on openings and holes required in precast members for electrical work.

P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.

Q. Examine and compare the Contract Documents with the drawings and specifications of other trades, and report any discrepancies between them to the Engineer and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.

R. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of Record Drawings.

S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed before coordinating with other trades.

T. Coordinate with the local electric utility company and the local telecommunications company as to their requirements for service connections and provide all necessary metering provisions, grounding, materials, equipment, labor, testing, and appurtenances. Provide all necessary communication and coordination with utility company as required the scheduling of all electric service power shutdowns.

New York State Electric and Gas
35 Milan Road Brewster, NY 10509
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U. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become

thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

V. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.

1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

W. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Engineer.

3.4 EXAMINATION OF SITE

A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.

B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for the satisfactory completion of the work.

3.5 EXCAVATION AND BACKFILL

A. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the Drawings or as required. Remove from the site excavated materials not required or suitable for backfill. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water, which accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.

B. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations

are required, excavate rock to a minimum overdepth of four inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth, thoroughly machine-tamped to a compaction level of at least 95 percent to standard proctor density or 75 percent relative density or as specified by the Civil Engineer. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

C. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown:

1. Electric service: Three (3) feet minimum.
2. Telephone service: Three (3) feet minimum.
3. Cable TV service: Three (3) feet minimum

D. Trenches should not be placed within ten feet of foundation or soil surfaces, which must resist horizontal forces.

E. Do not backfill trenches until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the Specifications. Backfill shall consist of non-expensive soil with limited porosity. Deposit in 6 inch layers and thoroughly and carefully tamp until the work has a cover of not less than one foot. Backfill and tamp remainder of trench at one-foot intervals until complete. Uniformly grade the finished surface.

F. Install warning tape in the trench backfill

G. Prior to filling in or covering over work, photo document the as-built utilities for record.

H. After filing in or covering over work, provide video inspection of each underground utility's interior to ensure that no damage occurred during the installation.

3.6 CUTTING AND PATCHING

A. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, lay out the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc., using skilled tradespeople of the trades required at no additional cost to the Owner.

B. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.

C. Where conduit or equipment are mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Utilize cold galvanized bare metal whenever support channels are cut.

D. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

3.7 MOUNTING HEIGHTS

A. Mounting heights shall conform to ADA requirements.

B. Verify exact locations and mounting heights with the Architect before installation.

C. Mounting heights of electrical device shall match what is indicated on the drawings. Use the following mounting heights if not indicated on the drawings (finished floor to center of device):

1. Electrical and telecommunications outlets: 15 inches, unless otherwise noted.
2. Lighting Switches/Wall Occupancy Sensors: 48 inches
3. Outlets for public and wall mounted telephones: conform to ADA mounting height.
4. Wall-mounted exit signs: 2 inches above top of door frame to bottom of sign.
5. Low-Level Exit Signs: 6" to bottom of sign.
6. Stairwell and utility corridor wall mounted fixtures: 8'-6" above finished floor or one foot below ceiling or structure above whichever is lower.

3.8 CLEANING UP

A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.

B. Clean all light fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.

C. All electrical equipment shall be thoroughly vacuumed and wiped clean prior to energization and at the completion of the project. Equipment shall be opened for observation by the Engineer as required.

3.9 WATERPROOFING

A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.

B. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

3.10 SUPPORTS

A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.

B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and mechanical equipment rooms.

C. Provide supporting frames or racks for equipment which is to be installed in a freestanding position.

D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.

F. Electrical equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of electrical equipment. Do not attach to supports provided for ductwork, piping or work of other trades.

G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Electrical equipment and supports shall not come in contact with work of other trades.

3.11 FASTENINGS

A. Fasten equipment to building structure in accordance with the best industry practice.

B. Where weight applied to building attachment points is 100 pounds or less, conform to the following as a minimum:

1. Wood: Wood screws.
2. Concrete and solid masonry: Bolts and expansion shields.
3. Hollow construction: Toggle bolts.
4. Solid metal: Machine screws in tapped holes or with welded studs.
5. Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.

C. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:

1. At concrete slabs provide 24-inch by 24-inch by 1/2-inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
2. At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with their decking or sub-floor, such hangers shall be provided.

D. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:

1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.

E. For items, which are shown, as being ceiling-mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

F. Wall-mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

3.12 IDENTIFICATION

A. Identify electrical equipment with permanently attached black phenolic nameplates with 1/2-inch high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates for equipment connected to the emergency power system shall be red with white lettering. Nameplates shall be attached with cadmium-plated screws; peel-and-stick tape or glue-on type nameplates are not allowed.

B. Cable tags shall be flameproof secured with flameproof non-metallic cord.

C. Provide an engraved nameplate for each switch controlling loads, which are not local to the switch.

D. Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1-inch by 1-inch clear heart redwood stake.

E. See individual Sections for additional identification requirements.

3.13 PROHIBITED LABELS AND IDENTIFICATIONS

A. In all public areas, the inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited, unless otherwise approved by Owner.

B. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

3.14 EQUIPMENT PADS AND ANCHOR BOLTS

A. Provide concrete pads under all floor-mounted electrical equipment. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 1-inch margin around the equipment and supports. Pads shall be a minimum of 4 inches high and made of a minimum 28 day, 2500 psi concrete reinforced with 6-inch by 6-inch 6/6 gauge welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bullnosed to a 3/4-inch radius.

B. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.

C. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative, the mounting screws may pass through the gypsum board and be securely attached to 6 inches square, 18 gauge galvanized metal backplates, which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not allowed.

3.15 DELIVERY, DRAYAGE AND HAULING

A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of drayage or storage.

B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc., at no additional cost to the Owner.

3.16 EQUIPMENT AND MATERIAL PROTECTION

A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.

B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

C. Provided adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.17 TESTING OF ELECTRICAL SYSTEMS

A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract close-out. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual Sections for extent of testing required.

B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within six months after the notice to proceed by Owner's Representative has been given. Update this schedule periodically as the project progresses.

3.18 OPERATING INSTRUCTIONS

A. Provide the services of factory-trained specialists to provide an operating instructions seminar for equipment and systems. The seminar shall be conducted over a five-day (consecutive) period. Instruction time is defined as straight time working hours and does not include nights, weekends, or travel time to and from the project.

B. Submit seminar agenda, schedule and list of representatives to the Owner for approval 30 days prior to suggested date of seminar. Do not commence seminar until the Owner has issued a written acceptance of the starting time and attendees. Confirm attendance of seminar by written notification to participants.

C. Instruct Owner's operating personnel in proper starting sequences, operation, shut-down, general maintenance and preventative maintenance procedures, including normal and emergency procedures.

D. Submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner at seminar.

E. Submit a written record of minutes and attendees of the seminar to the Owner.

3.19 OPERATING AND MAINTENANCE MANUALS

A. Provide Operating and Maintenance Manuals for equipment and materials furnished under this Division.

B. Submit three final copies of Operating and Maintenance Manuals for review at least ten weeks before the completion date. Assemble data in a completely indexed volume or volumes in three-ring binders and identify the size, model, and features indicated for each item. Print the project name on the outside of the binders.

C. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.

D. Provide the following information where applicable:

1. Identifying name and mark number
2. Locations (where several similar items are used, provide a list)
3. Complete nameplate data
4. Certified Record Drawings and Final Reviewed submittals
5. Parts list
6. Performance curves and data
7. Wiring diagrams
8. Manufacturer's recommended operating and maintenance instructions with all non-applicable information deleted
9. List of spare parts recommended for normal service requirements
10. Assembly and disassembly instructions with exploded-view drawings where necessary
11. Test reports
12. Trouble shooting diagnostic instructions, where applicable

3.20 RECORD DRAWINGS

A. The Contractor shall maintain on a daily basis at the Project site a complete set of black and white "As-built Drawings" reflecting an accurate dimensional record of all deviations between work shown on the Contract Drawing and that actually installed.

B. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two dimensions to permanent structures. In addition, mark the Record Drawings to show the precise location of concealed work and equipment, including concealed or embedded conduit and all changes and deviations in the electrical work from that shown on the Contract Documents. This requirement is not construed as authorization for the Contractor to make changes in the layout or work without written instructions from the Engineer.

C. AutoCAD files shall be electronically updated to record all revisions of the original drawings as actually installed. Bear the cost of making required changes. Upon completion of the installation, submit electronic PDFs and (1) set of black and white prints of these revised drawings to the Architect and Engineer for review of completeness.

D. After the Architect's and Engineer's review, and any required Contractor revisions, the Record Drawings shall be delivered to the Owner on electronic media in AutoCAD format. The Architect and Engineer

E. The Contractor and Subcontractor shall mark all in-progress Record Drawings on the front lower right hand corner with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
(3/8-inch high letters)

To be used for recording Field Deviations and Dimensional Data Only
(5/16-inch high letters)

F. Upon completion of the work, the Contractor and Subcontractor(s) shall certify all Record Drawings on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING
CERTIFIED CORRECT
(3/8-inch high letters)

(Printed Name of General Contractor)
(5/16-inch high letters)
Date:_____

(Printed Name of Subcontractor)
(5/16-inch high letters)
Date:_____

G. Indicate Contractor's firm name on the record and as-built drawings.

3.21 FINAL PUNCHLIST

A. Prior to the Final Punchlist, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.

B. At a time designated by the Owner with assistance from the Contractor, the installation will be reviewed for compliance with the Contract Drawings and Specifications. Contractor shall be available at all time during these surveys.

C. During the Final Punchlist, provide personnel with access keys, hand held radios, and necessary expertise to operate each system and piece of equipment to demonstrate operational compliance with the Contract Documents.

D. Any deficiencies noted on the Final Punchlist shall be expeditiously corrected and certified in writing.

3.22 PROJECT CLOSEOUT

A. At the time of project closeout and prior to the final payment, this contractor shall provide/submit the following for owner to review and sign off:

1. Review with Owner and confirm that all field issues are resolved.
2. Submit two (2) binder books with all electrical system testing report, equipment certificate and operation manual as per these specifications.
3. Submit electrical 3-phase load balancing report with the Engineer's review
4. Provide the Owner with required training as per these specifications.
5. Provide spare parts, fuses, switches, components, as per these specifications.
6. Turn all keys, including door access keys and panelboard keys to the Owner with proper tags.
7. Submit construction record as-built sets with A/E review stamp.
8. All proposals and change orders are fully executed and submit a certified statement that no change orders will be submitted after project closeout.
9. Submit copies of the Authority's inspection and approval letters.

END OF SECTION 260500

SECTION 260502 – ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Description of Work: Provide electrical removal work as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by the other trades.

1.2 EXISTING CONDITIONS

A. General: In general, existing electrical systems, equipment and devices are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing electrical conditions, where indicated, are based on casual field observations, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.

B. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

1.3 COORDINATION

A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and electrical systems and services must remain in operation at all times, unless specifically approved otherwise.

B. Scheduling: Electrical removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.

C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

1.4 ADJACENT MATERIALS

A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.

B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

A. Locate and identify any and all electrical services passing through the project area which serve areas outside the work limits.

B. Maintain all electrical services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.

B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing electrical materials and equipment at the project site. Items to be salvaged include, but not limited to, the following: Fire Alarm System Components, Lighting Fixtures, Clocks and Copper Feeders Size #4 AWG and Larger. Return these items to Owner, as directed.

3.2 COORDINATION

A. Coordinate all removal work with all other trades and utility companies, where applicable.

3.3 DEMOLITION

A. General: Remove electrical equipment, devices, raceways, wiring and related materials within the project work limits, as indicated.

B. Disconnections: Disconnect all electrical devices and equipment located in wall, ceilings or floors scheduled for removal and other equipment, as indicated. Disconnect electrical connections to mechanical and other equipment being removed by other trades.

C. Wiring Removals: Where existing electrical devices or equipment are indicated or required to be removed, remove all associated wiring. Remove all abandoned or dead wiring back to source or last active device as applicable.

D. Raceway Removals: Remove all abandoned raceway, boxes, supports, etc. where exposed (including those located above existing or new suspended ceilings and those located in cellars), and where they interfere with new work of any trade. Cut conduits flush with walls and floors and cap.

E. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.

F. Patching: When electrical materials are removed, patch and finish wall, surfaces, etc. to match surrounding surfaces. Provide blank cover plates as required etc.

3.4 EXISTING ELECTRICAL WORK TO REMAIN

A. General: Protect and maintain access to existing electrical work which must remain. Reinstall existing electrical work disturbed.

B. Special attention shall be given to modification of existing electrical branch circuits with common (shared) neutral conductor connections. Prior to any disconnection and removal work, all existing branch circuitry with a common neutral connection shall be traced out to identify all areas served. For portions of this circuitry that supplies areas outside the work limits, locate and de-energize associated overcurrent devices for the duration of the demolition work. Provide reconnection of common neutrals as required to assure proper operation for all existing branch circuitry to remain. Upon completion of work, restore power to all areas.

C. Reconnections: Where electrical work in adjoining areas or electrical work indicated to remain, becomes disconnected or affected by demolition work, reconnect circuits, etc., as required, to restore original operation. Restoration work to comply with requirements for new work.

3.5 EXISTING ELECTRICAL WORK TO BE RELOCATED

A. General: Disconnect, remove, reinstall and reconnect existing devices and equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

3.6 SHUTDOWNS

A. General: All shutdowns to existing electrical services to be scheduled and approved, in writing, by the Owner.

3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.

B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.

C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.8 CLEANING

Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 260502

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

C. Qualification Data: For testing agency.

D. Field quality-control reports.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.

3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors.

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

G. Armor: Steel, interlocked.

H. Jacket: PVC applied over armor (when Specified).

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.4 INSULATING TAPE

A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:

1. 8.5 Mil minim thickness.

2. ASTM D-3005 Standard specification for low-temperature resistant vinyl Chloride plastic pressure-sensitive electrical insulating type – type1.
3. Rated 600 volts and 150°C, suitable for indoor and outdoor applications.
4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.
5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight
6. Tape manufacturer: 3M “Scotch Super 88” or approved equal.

2.5 MANUFACTURERS

A. Wire Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Southwire Company
2. General Cable
3. The Okonite Company

B. Connectors Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Hubbell
2. Thomas & Betts
3. 3M Company

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders/Branch circuits: Copper; solid for No. 10 AWG and No. 12 AWG; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway;

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway;

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Contract drawings do not indicate size of branch circuit wiring; use No.12 AWG as a minimum wire size for branch circuit wiring. For 20 Ampere branch circuits whose length from the panel to the furthest outlet exceeds 100 feet for 120-volt circuits or

150 feet for 277-volt circuits; use No. 10 AWG or larger for the entire branch circuit installation.

C. A shared neutral may be utilized for circuits other than circuits used for dimmers, ground fault interrupter receptacles or circuit breakers, isolated ground receptacles, and isolated ground surge suppressor type devices

D. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.

E. 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.

F. Do not install wire in incomplete conduit runs nor until after concrete work and plastering is completed and moisture is swabbed from the conduits. Eliminate splices where possible. Where necessary, splice in readily accessible pull, junction or outlet box.

G. Take precautions to avoid entrance of dirt and water into the conduit and cuts. Clean conduits and ducts to remove and pulling compound prior to pulling cables. Do not damage conductor insulation, braid jacket or sheet during installation. Any damaged conductors shall be replaced immediately.

H. Use pulling means, including fish tape, cable, rope, cable reels on jacks, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not exceed maximum recommended pulling tension of wire and cable

I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

J. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Except where lugs are furnished with equipment, Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Circumferential compression type connector (provide for splices and connections No. 6 AWG and larger)
   1. Use for incoming and outgoing cable connections at enclosures and for ground connections.
   2. Use manufacturer's approved tool and correct size hex head with embosses die number on the connector or lug.
   3. Make crimped indentions parallel with insulation putty.
   4. Fill voids and irregularities with insulation putty.
   5. Cover nearly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two (2) directions.

D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

A. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to the project specifications.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line/riser diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.
    i. Insulation resistance to comply with ICEA values.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

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. Category 6 balanced twisted pair cable.
   2. Balanced twisted pair cabling hardware.
   3. RS-485 cabling.
   4. Low-voltage control cabling.
   5. Control-circuit conductors.
   6. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

   1. Testing Agency's Field Supervisor: Currently certified by BICSI to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches (1520 mm) or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP)

E. Cable Rating: Plenum.

F. Jacket: Blue thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair cable.

G. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.

2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:
   a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
   b. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
4. Marked to indicate transmission performance.

J. Faceplate:

1. Four port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.
   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, one pair twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.

3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, one pair No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30)] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.6 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.7 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by [1-1/2 inches (38 mm)] [2-1/8 inches (53 mm)] deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches (75 mm) above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.

5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.

2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).

3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
   c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide a complete grounding system in accordance with the Contract Documents and as specified herein.

1.2 SUBMITTALS

A. Minimum 1/8" scale floor plan drawings depicting the building ground electrode system as to be installed.

B. Detailed riser diagram depicting the building ground electrode system and bonding as to be installed.

C. Product data sheets (cut sheets) for all ground bus bars and other components of the grounding system.

D. Field test reports.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. 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.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

C. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

D. Conduit Hubs: Mechanical type, terminal with threaded hub.

E. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

F. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

G. Straps: Solid copper, copper lugs. Rated for 600 A.

H. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

I. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

J. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.
   a. Material: Die-cast zinc alloy.
   b. Listed for direct burial.
2. U-bolt type with malleable-iron clamp and copper ground connector.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

B. Ground Plates: 1/4-inch-thick, hot-dip galvanized.

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 copper conductor, No. 2 AWG minimum.

1. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated on drawings.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

B. At utility transformer, ground per utility company requirements and standards.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

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. Grounding Manholes and Handholes: Install a driven ground rod within 2 inches of wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Install conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Refer details on drawings.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. 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. Use Exothermic welds for all below-grade connections.
3. 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 bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance no fewer 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.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Manhole Grounds: 10 ohms.

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 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
   a. Hangers.
   b. Steel slotted support systems.
   c. Nonmetallic support systems.
   d. Trapeze hangers.
   e. Clamps.
   f. Turnbuckles.
   g. Sockets.
   h. Eye nuts.
   i. Saddles.
   j. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Performed steel channels and angles with a minimum of 13/32-inch diameter holes at a maximum of 8 inches o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Stainless Steel, Type 304
3. Channel Width: 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel, Stainless-steel or Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Mechanical-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 where used.
2. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: Stainless-steel springhead type.
6. Hanger Rods: Threaded stainless- steel.

2.2 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Allied Tube & Conduit; a part of Atkore International.
2. B-line, an Eaton business.
3. CADDY; a brand of nVent.
4. Thomas & Betts Corporation; A Member of the ABB Group.
5. Unistrut; Part of Atkore International.

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 unless requirements in this Section are stricter.

B. Provide nonmetallic coated steel slotted channel to support PVC conduit run inside building and in damp/corrosive environments.

C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway:
1. Support vertically installed raceways less than 2 inches trade size at intervals no greater than 8 feet. Support such raceways 2 inches trade size or larger and made up with threaded couplings, at intervals no greater 15 feet.
2. Support horizontally installed raceways less than 1 inch trade size at intervals no greater than 6 feet. Support such raceways 1 inch trade size or larger, at intervals no greater than 10 feet.
3. Minimum rod size shall be 1/4 inch in diameter.

D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
1. Secure raceways and cables to these supports with two-bolt conduit clampers.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

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.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.
5. Pull and junction boxes.
6. Floor Boxes.
7. Recessed Outlet Poke-Through Devices.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing

B. FMC: Flexible metal conduit

C. GRC: Galvanized rigid steel conduit.

D. MC: Metal Clad Cable

E. LFMC: Liquid-tight flexible metal conduit

F. RNC: Rigid nonmetallic conduit

1.3 SUBMITTALS

A. Product Data: For Cable, conduit, surface raceways, wireways and fittings, pull boxes, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. MC: Comply with UL 1569 and NEC article 330.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; single strip, continuous, flexible interlocked double-wrapped steel, galvanized inside and outside forming smooth internal wiring channel.

F. LFMC: Flexible steel conduit with PVC jacket, UV stable, machine tool gray in color, lightweight aluminum core internal construction and complying with UL 360.

G. Metal Fittings: Comply with NEMA FB 1 and UL 514:

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Set-screw type.
   b. In slab or concrete work, concrete tight fittings
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Fittings for LFMC: Body, gland and lock nut shall be steel of malleable iron. Ground cone shall be steel, sealing ring and insulator shall be blue molded thermoplastic at 150°C (221°F) maximum.
5. Fittings for GRC: Threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.

H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged cover secured with captive screws unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish NEMA 250 rated.

2.3 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways:
1. Refer to drawings for location(s), type(s), and quantity(s) of surface metal raceway.
   a. Surface finish: be satin, anodized #204 type clear, Class R1 mil-Spec with minimum anodized finish of .004” unless otherwise noted.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations. Provide the NEMA type listed below as required for the environment and use:
1. Type 1: for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).
2. Type 3R: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on

the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.

3. Type 12: for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are allowed.

K. 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.

6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2.6 FLOOR BOXES

A. Classification and Use: Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and/or UL514C and Canadian Standard C22.2, No. 18.1-04 and 18.2-06 and bear the U.S. and Canadian UL Listing Mark. Floor boxes shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the floor boxes). Floor boxes shall also conform to the standards set in Section 300-21 of the National Electrical Code. Floor boxes shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. Floor boxes shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, bare concrete, terrazzo, wood, and carpet covered floors. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the National Electrical Code.

1. Single Service Boxes: The floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be 13-1/8" L x 6-1/2" W x 2-5/8" H. There shall be two independent wiring compartments that allow capacity for up to two duplex receptacles and/or communication services. The box shall permit tunneling from end power compartment to end power compartment. Each of the two compartments shall have a minimum wiring capacity of 38 cu in. The box shall provide the following number of conduit knockouts: (2) 1/2" and (12) 3/4". The box shall be fully adjustable, providing a maximum of 1 3/8" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting plates that will

accept both duplex power devices, as well as plates that will accommodate open system devices.

2.7 RECESSED OUTLET POKE-THRU DEVICES

A. Poke-thru devices provide an interface between power, communication and audio/visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power, communication and/or A/V device outlets are required. These devices provide recessed device outlets that will not obstruct the floor area. Refer to the Drawings for types.

B. Classification and Use: Poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to comply with UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark. Poke-thru device shall also have been tested by UL and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. The poke-thru device shall conform to the standards set in the National Electrical Code, Section 300-21.

C. Poke-thru devices shall be classified for use in 1, 1-1/2, or 2-hour rated floors and 1, 1-1/2, or 2 hour rated floors employing unprotected steel floor units and concrete toppings, or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru device fittings. Poke-thru device assemblies shall consist of an insert and an activation cover.
   1. Insert: Insert body shall recess the devices a minimum of 2-3/4 inches (69mm) and have a polyester based backing enamel finished interior; ivory color. Furnish with necessary channels to provide complete separation of power and communication services. Provide three (3) compartments that allow for up to three (3) duplex receptacles that can be wired as a standard receptacle or isolated ground and/or 12 communication ports. Body consists of an intumescent firestop material to maintain fire rating of the floor slab. Hold intumescent material securely in place in insert body. Intumescent material will not have to be adjusted to maintain fire rating of the unit and the floor slab. Provide insert with a retaining feature to hold the poke-thru device in the floor slab without additional fasteners. Poke-thru insert shall also consist of a 3/4-inch trade size conduit stub that is connected to the insert body and a 24.5 cu in (402ml) stamped steel junction box for wire splicing and connections. Stamped steel junction box shall also contain the means necessary to electrically ground the poke-thru device to the system ground.
   2. Activation Cover: Manufactured of die-cast aluminum alloy; finished in powder-coated [gray] [black] [brass] [nickel] [bronze]. Provide with two (2) gaskets (one (1) for surface and one (1) for flush) to go under the trim flange to maintain scrub water tightness. Activation cover is 7-1/4 inches (184mm) in diameter. Provide

cover with spring-loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible. Provide activation unit with three locations to mount communication connectors. Mount connectors using a mounting bracket capable of accepting up to 12 Ortonics® TracJack™ Category 6 insert modules or TechChoice™ Category 6 discrete keystone connectors. Also provide unit with two (2) Category 6 discrete keystone connectors and two (2) industry standard keystones and accommodate a mechanism to permit protection of communication cabling. Fabricate mechanism from stamped steel construction. Mechanism shall accept both flexible and rigid 3/4-inch, 1-1/4-inch or two-inch trade size conduit.

2.8 MANUFACTURERS

A. Raceway and Fitting Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Wheatland Tube
2. Allied Tube & Conduit
3. Thomas & Betts
4. Hubbell
5. Legrand
6. Calbond
7. Plasti Bond
8. Western Tube and Conduit
9. Republic Conduit
10. Crouse-Hinds

B. Wireways, surface raceways, boxes, enclosure and cabinets Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Legrand
2. Hubbell
3. Thomas & Betts
4. Hoffman
5. OZ Gedney
6. Appleton Electric Company
7. Crouse-Hinds

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. The following application must be adhered to. Raceways installed not conforming to this listing must be removed and replaced with specified material at no additional expense.

Raceway Types	Applications
Galvanized Rigid Steel Conduit (GRC)	Where exposed to mechanical injury, where specifically required; indoors where exposed to moisture, where required by codes and for all circuits in excess of 600 volts. Outdoor locations, sump and ejector pits, elevator pits, loading docks, garages, rooftops, gymnasiums and Boiler/Mechanical Rooms/Main Electrical Rooms: exposed below10'-0" AFF.
Electrical Metallic tubing (EMT)	Use in every instance except where another material is not specified.
Metal Clad Cable (MC)	Lighting and receptacle branch circuits concealed in dry hollow spaces of a building. May not be used in areas where it would be subjected to physical damage or prohibited by Code.
Flexible Metal Conduit (FMC)	Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings; at all transformer or equipment raceway connections where sound and vibration isolation is required.
Liquid-Tight Flexible Metal Conduit (LFMC)	Use in areas subject to moisture where flexible metal conduit is unacceptable, at connections to all motors, and all raised floor areas.
Rigid Non-Metallic Conduit (RNC)	Schedule 40 - Where raceways are in a slab below grade levels; for raceway duct banks. Schedule 80 - For underground raceways outside of the building which are not encased in concrete.

Raceway Types	Applications
Wireways and Auxiliary Gutters	Where indicated on the Contract Documents and as otherwise specifically required.
Boxes and Enclosures	NEMA 250, Type 1, except use NEMA 250, Type 4 in kitchens and damp/or wet locations. Outdoors use NEMA 250, Type 3R.

B. Provide separate raceways for all wiring systems, including security, data, paging, low voltage et al. All 480Y/277 volt wiring must be kept independent of 208Y/120 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Provide grounding conductor within all circuits. Minimum size 3/4-inch for home runs and 1-inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid Galvanized Steel Conduit (GRC): Use threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
2. EMT: Use setscrew steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface raceways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

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. Install capped bushings on the raceways as soon as they are installed and remove only when cables are pulled. Securely tie embedded raceway in place prior to embedment.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab. Raceways installed below or in floor slabs must extend a minimum of 4 inches above the finished slab to the first connector.

F. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Install exposed raceways parallel or at right angles with building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduits in a junction box, which after completion is accessible to facilitate future branch circuit extension. Provide pull lines in each raceway.

J. Raceways in hung ceilings shall be installed on and secured to the slab or primary structural members of the ceiling, not to lathing channels or T-bars, Z-bars or other elements which are direct supports of the ceiling panels. Secure conduit firmly to the steel with clips and fittings designed for that purpose. Install as high as possible but not less than 1'-0" above the hung ceilings.

K. Raceways Embedded in Slabs:

1. Install no raceway in the concrete slab except with the permission of the Structural Engineer and written consent of the Owner.
2. Do not install raceways larger than 1-1/4 inch size in structural concrete slabs.
3. In no case will the installation of raceways be permitted to interfere with proper placement of principal reinforcement.
4. Place raceways in the structural slabs between the upper and lower layers of reinforcing steel. Careful bending of the conduits is required.
5. Space the raceways embedded in concrete slabs not less than eight (8) inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
6. Install raceways running parallel to slabs supports, such as beams, columns and structural walls, not less than 12 inches from such supporting elements.
7. Secure saddle supports for conduit, outlet boxes, junction boxes, inserts, etc. with suitable adhesives during concrete pour of the slab to prevent displacement.
8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Clear all raceways of all obstructions and dirt prior to pulling in cables. Use ball mandrel (diameter approximately 85% of the conduit inside diameter) followed by close fitting wire brush and wad of felt. This assembly may be pulled in together with, but ahead of any cable being installed. Clean all empty raceways similarly. Clear any raceway which rejects ball mandrel, then re-attempt mandrel application.

S. Install labeled pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 5 feet of slack at each end of pull wire. Tag both ends of the cable denoting opposite and termination location with black India ink on flameproof linen tag. Cap underground raceways designated as spare above grade alongside raceways in use.

T. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

X. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
6. Provide necessary bonding conductor for each raceway expansion joint.

Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFNC in damp or wet locations not subject to severe physical damage.

Z. OUTLET, JUNCTION, AND PULL BOXES

1. Provide outlet, junction, and pull boxes as indicated on the Contract Documents and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of the cables. Size the junction boxes and pull boxes per the NEC. Size the boxes on any empty conduit systems as if containing conductors of No.4 AWG.

2. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

3. The exact location of outlets and equipment is governed by the structural conditions and obstructions, or other equipment items. Verify locations of boxes and outlets prior to rough in. Thoroughly examine the architectural elevations and millwork shop drawings. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with the Architect prior to installation.

4. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Provide 12-inch minimum spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.

5. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one (1) switch or device is located at one (1) point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes are not permitted. Provide tile box or 4 inch square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in the same box, provide suitable barrier(s).

6. All outlet and device box depths shall have sufficient depth to prevent damage to the conductors when devices or utilization equipment are installed as intended in

7. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

8. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

9. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

10. Locate boxes so that cover or plate will not span different building finishes.

11. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

12. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

13. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.

14. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

a.	Toggle switches	46″
b.	Receptacle outlets	18″
c.	Receptacle outlets, weatherproof, above-grade	24″
d.	Data/Telephone outlets	18″
e.	Fire alarm manual station	46″
f.	Fire alarm audio/visual	80″

15. Types of Boxes and Fittings for Various Locations:

Location	Type
Outlet	Galvanized pressed steel
Outlet exposed to moisture or outdoors	Cast type conduit fitting
Splice	Galvanized pressed steel
Splice exposed to moisture or outdoors	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction - Outdoors	Aluminum (4½" x 5" x 3" minimum)
Terminal	Sheet steel (6" x 6" x 3" minimum)
Terminal - Outdoors	Aluminum (6" x 6" x 3" minimum)

AA. PULL BOX SPACING

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360° total).

2. Conduit Sizes 1¼" and Larger:
   a. Provide boxes to prevent cable from being excessively twisted, stretched or flexed during installation.
   b. Provide boxes so that maximum pulling tensions do not exceed the cable manufacturer's recommendations.
   c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside the box.
3. Conduit Sizes 1 inch and Smaller, provide boxes at every (Maximum Distances):

Distance	Run Type
150 feet	straight runs
100 feet	runs with one (1) 90° bend or equivalent
75 feet	runs with two (2) 90° bends or equivalent
50 feet	runs with three (3) or (4) four 90° bends or equivalent.

4. Boxes shall be sized to permit pulling, racking and splicing of cables (if not indicated on the contract drawings). They shall be sized to avoid exceeding the manufacturer's minimum bending radius recommendations for conductors.
5. Provide access for the removal and replacement of the conductors, splices and equipment.

6. Minimum distance of boxes in runs of 1-1/2 inch or larger conduit:
   a. Straight pulls: size length 8 times nominal diameter of the largest conduit.
   b. Angle or U-pulls: size such that the distance between the conduit entry and the opposite wall of box is 6 times the nominal diameter of the largest conduit.

7. Covers: fasten to the flange or framework of the box with machine bolts, machine screws threaded into tapered holes or sheet metal screws as required.

8. Identification labels for all pull, splice and junction boxes in main feeder and sub-feeder runs, shall indicate nominal system voltage:
   a. Apply labels after painting of any boxes, conduits, and surrounding areas are completed.
   b. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.
   c. Apply labels on the cover and a minimum of 1 fixed side; 1 label visible from the floor where the boxes are installed exposed.

3.3 FIRESTOPPING

A. Install firestopping at penetrations of all fire-rated floor and wall assemblies, per the project specifications.

3.4 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 260534 – MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes the following:

1. Manholes
2. Handholes.
3. Accessories.

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casting materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as a component of a duct bank.

C. Duct Bank:

1. Two or more duct installed in parallel, with or without additional casting materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 SUBMITTALS

A. Product Data:

1. Manholes and handholes.
2. Accessories.
3. Warning tape.
4. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include dimensioned plans, elevations, sections, details, attachments to other work, and

accessories, including frame and cover design, grounding detail, cable rack inserts, sumps and pulling irons.

1.4 QUALITY ASSURANCE

A. Comply with the latest applicable provisions and latest recommendations of the governing codes and the Contract Documents.

B. U.L. Listing of all products.

1.5 COORDINATION

A. Coordinate layout and installation of manholes and handholes with the final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of manholes and handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features.

PART 2 - PRODUCTS

2.1 GENERAL

2.2 HANDHOLES (UNDERGROUND PULLBOXES)

A. Description: Factory-fabricated, reinforced pre-cast concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of the enclosure and shall have a load rating consistent with that of a handhole.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
3. Cover Legend: Molded lettering as indicated on the plans.
4. Configuration: Units shall be designed for flush burial and have a closed bottom.
5. Extensions and Slabs: Designed to mate with the bottom of enclosure. Same material as the enclosure.

6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
   a. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
   b. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.
7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
8. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Acceptable Manufacturers:

1. Quazite
2. Christy Concrete Products
3. Oldcastle Precast Group.
4. Utility Concrete Products, LLC.

2.3 HANDHOLES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Configuration: Units shall be designed for flush burial and have closed bottom.
2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure.
3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering as indicated on the plans.
5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings.
6. Duct Entrance Provisions: Duct-terminating fittings shall mate with the entering ducts for secure, fixed installation in the enclosure wall.
7. Handholes shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Handholes shall comply with the requirements of SCTE 7 Tier 22 loading.

1. Acceptable Manufacturers:
   a. Quazite
   b. Armorcast Products Company.

c. Oldcastle Enclosure Solutions
d. Hubbell Power Systems

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037 and SCTE 77.

PART 3 - EXECUTION

3.1 GENERAL

A. Excavation, sharing, bracing, back-filling and grading provided by other section.

B. Manholes shall be constructed as shown on the Contract Drawings. Manholes shall not be constructed until final conduit grading has been determined, including any field changes required by underground interferences. Shop drawings shall be submitted for all manhole details that differ in any way from those shown on the Contract Drawings.

C. Cables to be secured with tie-wraps. Cable racks shall be fiber.

D. Provide a copper clad steel ground rod, 3/8 inch by 10 feet long, in each manhole. All noncurrent-carrying metal parts in manholes and handholes including metallic sheaths of cables, shall be connected to the ground rod by a bare copper ground conductor. Install the ground rod with top protruding 4 inches above manhole floor.

E. Provide a cast iron sump frame and cover for each manhole. Provide 12-by 12-by 6-inch deep sump. Excavate below sump 6 inches and fill sump bottom with clean gravel. Slope floor of manhole 1/8-inch per foot to the edge of the sump.

F. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum.

G. Attach cable racks to inserts after manhole.

H. Manholes and handholes are shown on the Contract Documents in approximate locations. The exact location shall be field determined after careful consideration of other utilities, grading, and paving.

I. In paved areas, set top of frame and cover flush with finished surface. In unpaved areas, set top of frame and cover approximately ½ inch above finished grade.

J. The installation of manholes shall be in an excavated area free of obstructions for a minimum 6 inches around outside perimeter, with a 6 inch compact gravel base of uniform thickness and level. The preparation of the base shall insure no settlement. Backfill shall consist of good compactable material, such as pea gravel, sand or clean earth fill. Backfilling should be done progressively from bottom to top surface. Minimum earth cover from roof of manhole to finished grade shall be 8 inches.

K. Concrete encased duct banks entering wall may be cast in the concrete or enter through opening of suitable dimensions and arrangement. Where openings are provided, caulk the space between duct bank and walls tight with lead wool or other suitable material. Reinforce iron of the ductbank to be connected to the wall.

L. Flush end bells shall be mounted on side walls where duct enters.

M. Duct entrances shall be carefully planned via the field for best application of cable pulling and racked. All cables shall be secured with tie-wraps to porcelain saddles.

N. Waterproofing shall be done in accordance with manufacturer's instructions.

O. Collar shall be cast concrete rings, stacked to required height. Set height in field per final grade elevations.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Traffic Paths: Precast concrete.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 22 structural load rating.

3.3 EARTHWORK

A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated on the Contract Documents. Replace removed sod immediately after backfilling is completed.

3.4 INSTALLATION OF CONCRETE MANHOLES AND HANDHOLES

A. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel and compacted to same density as adjacent undisturbed earth.

B. Elevations:
1. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
2. Install handholes with bottom below the frost line.
3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.

C. Drainage: Install drains in bottom of manholes where indicated.

D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors.

E. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.5 INSTALLATION OF HANDHOLES OTHER THAN PRECAST CONCRETE

A. Install handholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded and compacted to same density as adjacent undisturbed earth.

C. Elevation: Set so cover surface will be flush with finished grade.

D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors.

E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi (20 kPa), 28-day strength.
2. Dimensions: 10 inches wide by 12 inches or as indicated.

3.6 GROUNDING

A. Ground underground ducts and utility structures.

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in this division."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260534

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

1. Underground Duct System
2. Conduits
3. Nonmetallic Ducts
4. Duct Accessories

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank: Two or more ducts installed in parallel, with or without additional casing materials.

D. GRC: Galvanized rigid (steel) conduit.

E. RNC: Rigid nonmetallic Conduit.

F. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 SUBMITTALS

A. Product Data:
   1. Duct bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Warning tape.
   4. Warning planks.

B. Shop drawings for dimension underground structure: including plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details.
   3. Grounding details.

4. Duct bank coordination drawings showing dimensioned duct profiles and coordination with other utilities and underground structures. Include plans and sections drawing to scale and show bends and locations of expansion fittings.

C. Submittal results of field tests.

D. Record documents: show dimensional locations of all underground ducts, handholes, and manholes.

PART 2 - PRODUCTS

2.1 UNDERGROUND DUCT SYSTEM

A. Contractor shall furnish and install raceways and fittings for an underground duct system, as indicated on the Contract Drawings and specified herein.

B. All bends at underground duct system shall be per the manufacturer's bending requirements.

C. Raceways shall transform from EPC (electrical plastic conduit) PVC to rigid galvanized steel conduit within 10 feet of any foundation walls. Run EPC PVC duct bank to the manholes. Contractor shall furnish and install proper couplings to accommodate aforementioned transition.

D. Where offsets are required to clear obstructions and other underground services, a maximum of 5° angle will be allowed at duct joints.

E. Ducts shall be installed so as to drain to the manholes. Ducts entering into the point of entry (P.O.E.) room shall be installed with upward slope of minimum of 0.125 inch/foot.

F. All raceways as previously described shall utilize a mandrel of sufficient size to thoroughly clear raceways of all obstructions prior to the installation of any wiring.

G. All concrete construction, excavation and backfill for the underground ductbank system shall be described under other sections of the project specifications. Red dye shall be added to the concrete mixture.

H. All conduits penetrating into the buildings shall be totally sealed in order to prevent any migration of water through the ductbank into the building.

I. Prior to backfilling of the underground duct system, provide conducting underground-line warning tape as specified in section 260553 "Identification for Electrical Systems". Bury tape 12 inches below grade for all ducts and ductbanks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each

12 inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

2.2 CONDUITS

A. Galvanized Rigid Steel Conduit (GRC): Comply with ANSI C80.1 and UL 6.

B. Rigid nonmetallic conduit (RNC): Type EPC-80-PVC or Type EPC-40-PVC, as specified on the plans, complying NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by the same manufacturer as the conduit.

2.3 NONMETALLIC DUCTS

A. Schedule EPC-40-PVC conduit shall be used for all concrete encased duct banks.

B. PVC conduits shall not be used within the building area unless otherwise noted.

C. All penetrations through floor slabs or foundation walls shall be rigid steel conduits. No RNC conduit shall be used in or through any floor slab.

D. PVC conduits shall not be allowed under paved areas, which are subjected to vehicular traffic. Concrete encased rigid steel conduit shall be used.

E. Concrete encased Schedule EPC-80-PVC shall be allowed under paved areas, subjected to vehicular traffic. Schedule EPC-40-PVC is not allowed.

2.4 DUCT ACCESSORIES

A. Duct Separators (Spacers)
   1. Factory-fabricated rigid PVC interlocking spacers, High impact polystyrene sized for type and sizes of ducts with which used and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   2. Telco carrier ducts shall be separated from electrical ducts by a minimum of 36" and shall cross electrical ductbanks at 90-degree angle only, when unavoidable.

2.5 MANUFACTURES

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

   1. Allied Tube & Conduit; a part of Atkore International.
   2. CANTEX INC.
   3. Western Tube and Conduit Corporation.

4. Wheatland Tube Company.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.

C. Ducts smaller than 2″ trade size for Electrical Branch Circuits: NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

D. Ducts smaller 2″ and larger trade size for Electrical Branch Circuits: NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

3.2 EARTHWORK

A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, frizzling, liming, seeding, sodding, springing, and mulching.

3.3 DUCT INSTALLATION

A. Concrete for conduit envelopes shall be as required or as specified under other Divisions of the project specifications. Red dye shall be added to concrete mixture. Concrete shall extend at least 3 inches beyond exterior surface of each conduit in bank.

B. Trenches shall not be backfilled until concrete envelopes have had sufficient time to set. After concrete envelopes have set, nonmetallic conduits shall be cleared with mandrel of the same size as the conduit.

C. Cap ends of spare conduits 5 feet beyond pavement and protect them from mechanical damage. Mark the location of conduit ends with concrete monuments, 6 inches in diameter by 18 inches long, set flush in the ground with "S/C" indented in the top.

D. Arrange multiple conduits as shown on the Contract Drawings. Make minor changes in location, or cross-sectional arrangement as necessary. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches, request the Architect's instructions before further work is done. Coordinate this work with other outside service work.

E. Slope: Pitch ducts a minimum slope of 0.125 inch/ft down toward the manholes and handholes and away from the buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

F. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12 times the conduit diameter, both horizontally and vertically, at other locations unless otherwise indicated.

G. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

H. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition.

J. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf test nylon cord in ducts, including spares. Label each line.

3.4 Concrete-Encased Ducts:

A. Support ducts on duct separators coordinated with duct size, duct spacing and outdoor temperature.

B. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators

approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

C. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

1. Where more than one (1) pour is necessary, provide ¾ inch reinforcing rod dowels extending 18 inches into concrete on each side of joint. Concrete envelopes installed over extensive area of disturbed earth shall have a separate concrete base.

D. Concrete envelopes that cross other conduits or pipelines or are run under roads and driveways shall be reinforced. Provide reinforcement where envelopes connect to manhole and building walls. Concrete envelopes that terminate for future extension shall have dowels as specified for joints between pours.

E. Use walls of trench to form side walls of duct bank where soil is self-supporting, and concrete envelope can be poured without soil inclusions; otherwise use forms. Remove loose dirt and extraneous material. Concrete shall be spaced during pouring to eliminate voids under and between conduits and to prevent honeycombing of exterior surfaces. Power-driven tampers or agitators shall not be used. Secure bolts sufficiently to prevent movement during concrete placement.

F. Minimum Space between Duct: 3 inches between edge of ducts and exterior envelope wall, 3 inches between ducts for like services, and 4 inches between power and communication ducts.

G. Depth: Install top of duct bank at least 36 inches below the finished grade unless otherwise indicated.

H. Stub-Ups: Use manufactured GRC elbows for stub-ups at utility poles, equipment and at building entrances through the floor.

1. Couple RNC to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
2. For equipment mounted on outdoor concrete bases, extend concrete encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

3.5 Direct-Buried Duct and Duct Bank:

A. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.

B. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Stagger spacers approximately 6 inches between tiers.

C. Excavate trench bottom to provide firm and uniform support for duct bank.

D. After installing first tier of ducts, backfill and compact. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Place a minimum of 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.

E. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and communication ducts.

F. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.

G. Set elevation of bottom of duct bank below the frost line.

H. Install manufactured GRC elbows for stub-ups at utility poles, equipment and at building entrances through the floor.

1. Couple RNC to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
2. For equipment mounted on outdoor concrete bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.6 GROUNDING

A. Ground underground ducts in accordance with the "260526 - Grounding and Bonding of Electrical System" specification section.

3.7 FIELD QUALITY CONTROL

A. Preform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on the completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through each duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
4. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 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.

1.2 SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. 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 FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.3 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.

2.4 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.

2.5 MANUFACTURERS

A. Manufacturers subject to compliance with requirements, provide products by one of the following (no exceptions):

1. BWM Company
2. Flexicraft Industries.
3. GPT Industries
4. Metraflex Company (The).
5. Proco Products, Inc.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-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 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Paint for identification.
8. Fasteners for labels and signs.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

1. Color shall be factory applied.
2. Colors for 208/120-V Circuits:
    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.
    d. Neutral: White.
3. Colors for 480/277-V Circuits:
    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: Gray.
4. Color for Equipment Grounds: Green.
5. Colors for Isolated Grounds: Green with yellow stripe.

C. Raceways and Cables Carrying Circuits at more Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER – CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

F. Equipment Identification labels:

1. Black Letters on a white field unless otherwise noted.
2. Equipment supplied by the emergency system shall be white letters on a red field.

2.3 LABELS

A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Underground-Line Warning Tape:

1. Tape:
   a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   b. Printing on tape shall be permanent and shall not be damaged by burial operations.
   c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 TAGS

A. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015-inch-thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

B. Write-on Tags:

1. Polyester Tags: 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.6 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
   a. For signs up to 20 sq. in., minimum 1/16 inch.
   b. For signs larger than 20 sq. in., 1/8 inch thick.
   c. Engraved legend with black letters on white face.
   d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
   e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.

3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
   1. “POWER."
   2. "FIRE ALARM."

J. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

K. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

L. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

M. Nonmetallic Preprinted Tags:

   1. Place in a location with high visibility and accessibility.

N. Laminated Acrylic or Melamine Plastic Signs:

   1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
   2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

O. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "POWER."
2. "FIRE ALARM."

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted cable tags to identify each conductor. Tags shall indicate the load served, type, and size of cable the overcurrent device protecting the cable.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

F. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

G. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.
b. Controls with external control power connections.
c. Switchboards
d. Switchgear

I. Operating Instruction Signs: Self-adhesive labels.

J. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch high letters for emergency instructions at equipment used for power transfer.

K. Equipment Identification Labels:

1. Indoor Equipment: Engraved Backlite plates mounted with rivers or screws.
2. Outdoor Equipment: Laminated acrylic.
3. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Mount label at top of panel
   a. Include on directory of the panel the cable and raceway size of panel feeder and the feeder origination point.
4. Switchgear, Switchboards, substations, meter center, and motor controls center: furnish and install a master nameplate on each switchboard, substation, meter center and motor control center engraved with the equipment identification indicated on Contract Drawings. Mount at top of the incoming section.
   a. Provide on each main switch an identifying nameplate. Where multiple mains are employed each switch shall be numbered. Inscription shall be “Main Switch” or “Main Switch No. 1” et al.
5. Feeder switches in Switchboards, switchgear and motor control centers:
   a. One nameplate engraved with the load served, the size and type of cable and raceway used. Example:
      Panels LP-4,LP-5,LP-6
      4#500MCM-THWN-CU-3-1/2”C
6. Transformers: Provide nameplate that includes tag designation indicated on Contract Drawings for the transformer. Identify panelboards or equipment supplied by the secondary on nameplate label.
7. Enclosed disconnect switches and circuit breakers: nameplate engraved with equipment designation.
8. Variable-speed controllers and motor controllers: nameplate engraved with equipment designation. Coordinating final equipment names with mechanical contractor prior to fabrication.
9. Lighting control panels: Provide nameplate similar to that of panelboards.

END OF SECTION 260553

SECTION 260573 - ELECTRICAL POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish an Electrical Power System Study for electrical distribution system modifications performed by the work of this project as defined herein.

B. The study shall begin at the point of power source connection and include all downstream distribution and branch panelboards, motor control centers and significant motor locations (20HP and larger) included in the scope of work for this project. In addition, all equipment that is required to be rated for the available fault current shall be evaluated in the study including but not limited to transformers, enclosed switches, individual motor controllers, contactors, variable speed drives, and enclosed circuit breakers.

C. Where any part of the electrical system is served by multiple power sources, the system configuration that delivers the highest level of fault current shall be used for the evaluation.

1.2 SUBMITTALS

A. The final report shall be indexed and contain individual, tabbed sections. The tabbed sections shall contain the information as outlined in Part 2 of this document including the following:

1. Firm Name, Address, Phone Number and Professional Engineer's signature and seal of the registered professional Engineer that performed the study,
2. Method used to perform the study and analysis,
3. Short-circuit analysis with protective device evaluation,
4. Protective device coordination study,
5. Arc Flash Analysis,
6. Input Data,
7. One-line diagram.

1.3 REFERENCE STANDARDS

A. All studies shall be performed in accordance with the latest applicable industry standards including the following:

1. IEEE/ANSI Std 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
2. NEMA AB 3 – AB 3 Molded Case Circuit Breakers and their Application
3. NFPA 70 – National Electrical Code
4. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 QUALITY ASSURANCE

A. Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems.

B. Short-Circuit Analysis, Arc Flash Analysis and Coordination Study shall be performed by a New York State registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years' experience in the analysis, evaluation, and coordination of electrical distribution systems.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. If it complies with the specifications, the engineering study specified herein shall be prepared by the manufacturer providing the electrical switchboards and panelboards for this project or manufacturer's authorized engineer.

2.2 SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION

A. The study shall be submitted with the electrical service and distribution equipment submittal and shall indicate where device substitutions are being made in order to achieve adequate interrupting capacity ratings for each piece of equipment.

B. The study shall include recommended settings of adjustable overcurrent and ground fault devices.

C. Provide overcurrent protective devices of suitable type and rating to meet or exceed the available short circuit currents indicated in the short circuit study.

D. Interrupting capacities shall be based on a fully rated protection system where all overcurrent protection devices are rated for the full prospective short circuit current (as indicated in the final short circuit submittal). Series-rated panelboards are not permitted.

E. Obtain from the utility company (and confirm in writing) the short circuit current available at the utility company's transformer secondary.

F. Systematically calculate fault currents based on the available fault current at the facility service entrance. Study preparer shall obtain the maximum available fault current and power factor or X/R ratio of the fault current at the service entrance from the local utility.

G. Motor contribution for motors 50HP and larger shall be incorporated in determining fault levels.

H. Evaluate the distribution device and equipment ratings compared to the calculated fault current and make recommendations where equipment is overdutied. Analyze the short-circuit currents by preparing a tabulation comparing the fault levels to the device interrupting ratings. Indicate equipment in which series ratings are utilized.

I. When the power factor or X/R ratio of the maximum symmetrical fault calculated at the device location is determined to be more inductive than that used to establish the device interrupting rating adjust the available short circuit current in accordance with ANSI/IEEE standard 242.

J. Calculations shall be presented in tabular form and shall include:

1. Location identification
2. Voltage
3. Manufacturer and type of equipment
4. Equipment short-circuit current rating
5. Calculated short-circuit current (and adjustments due to high X/R ratio where required)
6. Calculated X/R ratio of the fault
7. Indicate if series ratings are used
8. Recommendations where equipment is calculated to be overdutied

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Prepare coordination time-current characteristic curves to determine the required settings of the protective devices to achieve selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves provided shall reflect actual protective devices (manufacturer

and model number) to be installed. Adequate time-current curves shall be generated to depict coordination.

B. The study shall include recommended settings of adjustable overcurrent and ground fault devices.

C. The coordination study shall include ground fault protection coordination and recommended device settings for the devices provided with ground fault protection.

D. Protective device characteristics shall be plotted to reflect calculated short-circuit levels at the location.

E. A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection. All curve sheets shall be multi-color or use hatching for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide recommendations to improve coordination.

F. The following information shall be provided on all curve sheets.

1. Device identification and associated settings/size.
2. Voltage at which curves are plotted.
3. Current multiplier.
4. ANSI frequent fault damage curve.
5. Cable insulation damage curves.
6. Transformer inrush point.
7. Single-line for the portion of the system.
8. Motor starting profiles (where applicable).

G. The recommended device settings shall be provided in tabular form and shall include:

1. Location Identification
2. Voltage
3. Device Manufacturer
4. Device catalog number/series
5. Adjustable long time pickup and delay
6. Adjustable short time pickup and delay
7. Adjustable ground fault pickup and delay
8. Adjustable instantaneous pickup

2.4 ARC FLASH ANALYSIS

A. An arc flash analysis shall be performed based on the short circuit values and device settings in conjunction with a short circuit and coordination study. The results from the short circuit and coordination study shall be used to determine arc energy levels at each power distribution location in the facility where work could be performed on energized parts.

B. Where any part of the electrical system is served by multiple power sources the system configuration that delivers the highest level of arc flash incident energy shall be used for the evaluation. Include significant motor contribution in the calculations.

C. For each location with a main device, the line and load side fault contributions shall be included in the calculations.

D. Arc Flash Calculation results shall be presented in tabular form and shall include:

1. Location identification
2. Voltage
3. Arcing fault magnitude
4. Protective device clearing time
5. Duration of arc
6. Arc flash boundary
7. Working distance
8. Incident energy
9. Hazard Risk Category

2.5 ARC FLASH WARNING LABELS

A. Arch Flash warning labels shall be provided as part of the report. Labels shall be self-adhesive Polyester, thermal, transfer-printer, 3-mil-thick, multicolor, weather and UV-resistant in accordance with ANSI Z535.4. Produce a minimum 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance

7. Engineering report number, revision number, and issue date.

C. Labels shall be machine painted, with no field-applied markings.

2.6 INPUT DATA

A. The study shall be conducted based on the equipment and conductors being installed. Input data for the report shall be compiled from the contractor, manufacturers, and codes and standards as required providing the studies and conducting a proper evaluation.

B. Conductor lengths, sizes, material, and raceway information shall be provided by the Electrical Subcontractor to the engineer performing the study so that the study is performed based on the final installation.

C. Input data used for the studies shall be provided in the final report. The input data for the report shall include supporting data from the manufacturer used for the evaluation, lengths of all feeders provided by the contractor, transformer data, motor data, utility company and motor generator data and any other supporting data to the report.

2.7 SINGLE-LINE DIAGRAM

A. The final report shall include a single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:

1. Transformer rating, voltage ratio, impedance, and winding connection.
2. Feeder cables per phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
3. Switchboards, panelboards, MCC's, individual motor controllers, variable speed drives, fuses, circuit breakers, ATS's and enclosed switches.
4. Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
5. Motor identification and horsepower used in the evaluation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The electrical equipment and protective devices shall not be installed prior to confirmation of adequate equipment fault ratings as specified herein.

3.2 FIELD SETTINGS

A. Adjustments shall be made to the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.

B. Arc Flash Labels shall be affixed to the equipment after the study is approved by the Engineer.

1. One label shall be affixed at a height and location that is clearly visible on the front of panelboards, switchboards, switchgear, motor control centers and other electrical equipment that is less than 8 feet in length unless otherwise noted.
2. Switchboards, motor control centers, and switchgear that are longer than 6 feet shall have labels affixed at a height and location that is clearly visible on the front of the equipment at each end of the equipment.
3. Transformers shall be labeled based on the high voltage side of the transformer.
4. Labels shall be affixed at similar locations on each type of equipment. For example, multiple panelboards of similar size shall have labels located at the same location on the front of each panelboard cover.
5. Where multiple labels are affixed to equipment, the labels shall be identical and identify the worse case information for that equipment.
6. Where equipment is rear connected affix labels on both the front and rear of the equipment. Locate the labels on the rear at a similar height and location as on the front.
7. Label each plug-in section of busway. Affixed at a height and location that is clearly visible. Labels shall be affixed on both sides of the busway.

C. Device settings and adjustments and affixing of Arc Flash Hazard Labels shall be by the manufacturer or the manufacturer’s authorized service and testing organization.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Switchbox-mounted occupancy sensors.
2. Standalone daylight-harvesting dimming controls.
3. Indoor occupancy and vacancy sensors.
4. Electronic time switches.
5. Outdoor photoelectric switches, solid state, flexible mounting.
6. Lighting contactors.
7. Exterior Lighting Control Panel.
8. Digital timer light switches.
9. Conductors and cables.

B. Related Requirements
1. Section 265619 "LED Exterior Lighting" for other Project requirements applicable to Work specified in this Section.

1.2 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:
   a. Occupancy sensors.
   b. Vacancy sensors.
   c. Daylight-harvesting dimming controls.
   d. Exterior Lighting Control Panel.
2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.4 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Faulty operation of lighting control devices.
2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Sensing Technology – Dual Technology.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level).
   b. When significant daylight is present.
2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool.
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated or separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.

C. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

D. Power Pack: Dry contacts rated for 20A ballast or LED load at 120V and 277V AC, for 13A tungsten at 120V AC, and for 1 HP at 120V AC. Sensor has 24V DC, 150mA, Class 2 power source, as defined by NFPA 70.

1. LED status lights to indicate load status.
2. Plenum rated.

E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with two outputs rated for 20A incandescent or LED load at 120V and 277V AC, for 16A ballast load or LED at 120V and 277V AC, and for 1 HP at 120V AC. Sensor has 24V DC Class 2 power source, as defined by NFPA 70.

1. With integral current monitoring
2. Compatible with digital addressable lighting interface.
3. Plenum rated.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated or Separate power pack.
4. Hardwired or Wireless connection to switch and BAS; and BAS and lighting control system.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:
    a. Occupancy Sensor: Unless otherwise indicated, turn lights and receptacles on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually

turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

7. Power: Low voltage or Line voltage.
8. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
10. Bypass Switch: Override the "on" function in case of sensor failure.
11. Automatic Light-Level Sensor: Adjustable from 2 to 100 fc; turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage: Select sensor(s) to provide full coverage of room and detect occupancy anywhere within the room where installed.

2.4 DIGITAL TIMER LIGHT SWITCH

A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. The digital time switch shall be programmable to turn lights off after a preset time.
3. Time switch shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.
4. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch’s longevity.

5. Time switch shall be compatible with all electronic ballasts, motor loads, compact fluorescent, LED and inductive loads. Triac and other harmonic generating devices shall not be allowed.
6. Time switch shall have no minimum load requirement and shall be capable of controlling all types of light sources.
7. Time scroll feature shall allow manual overriding of the preset time-out period.
8. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
9. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
10. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
11. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.
12. Time switch shall fit behind a decorator style faceplate. The calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
13. Time-out period shall be adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.
14. Time switch shall be capable of operating as an ON/OFF switch.
15. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.
16. For safety, in the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode

2.5 EXTERIOR LIGHTING CONTROL PANEL

A. Factory assembled panel with integral astronomical timer with 7-day scheduling, lighting contactor, USB for schedule data transfer/backup, backup power capacitor, remote inputs for photoelectric switch and manual switch override and input for surge protective device. Enclosure: Comply with NEMA 250. Basis of Design: Intermatic, Inc. Model Number ETCB28253PCR. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 20 A driver load, 120/240 V(ac).
4. Programs:
   a. 48 fixed ON and 48 fixed OFF operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
5. Circuitry: Allow connection of a photoelectric relay and manual override switch as substitute for on-off function.
6. Automatic daylight savings time changeover.
7. Power Backup: Supercapacitor - 100 hour reserve, to maintain schedules and time clock.

C. Lighting Contactors: Description: 120–480VAC 60 Hz with 120VAC control coil voltage. Electrically operated and mechanically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: 60 amp 3-pole – 3 x SPST. Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

2.6 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Die Cast metal stem mount electronic photocontrol. Basis of Design: Intermatic, Inc. Model number EK4436SM. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.

B. Description: Solid state, with SPST dry contacts rated for 1000 W incandescent or 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.

2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.
6. Failure Mode: Luminaire stays ON.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 INSTALLATION OF CONTROL PANELS

A. Mount panels with elastomeric isolator pads to eliminate structure-borne vibration unless integral lighting contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 INSTALLATION OF WIRING

A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
   1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.6 LIGHTING SYSTEM FUNCTIONAL TESTING

A. The lighting control system manufacturer, manufacturer’s authorized representative, or a qualified testing agency shall perform all functional testing required by the 2015 International Energy Conservation Code, Section C408.

B. Functional Testing:

   1. Prior to passing final inspection, the manufacturer’s authorized representative shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer’s instructions.

C. Occupancy Sensor Controls:

1. Certify that the occupancy sensors have been located and aimed in accordance with manufacturer recommendations.

a. For projects with seven or fewer sensors, each sensor shall be tested.

2. For occupancy sensor controls to be tested, verify the following:

a. Where occupancy sensor controls include status indicators, verify correct operation.

b. The controlled lights turn off or down to the permitted level within the required time.

c. For auto-on sensors, the lights turn on to the permitted level when an occupant enters the space.

d. For manual-on sensors, the lights turn on only when manually activated.

D. Time Switch Controls:

1. Where time switch controls are provided, the following procedures shall be performed:

a. Confirm that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.

b. Provide documentation to the owner of time switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.

c. Verify the correct time and date in the time switch.

d. Verify that any battery backup is installed and energized.

e. Verify that the override time limit is set to not more than 2 hours.

2. Simulate occupied condition. Verify and document the following:

a. All lights can be turned on and off by their respective area control switch.

b. The switch only operates lighting in the enclosed space in which the switch is located.

3. Simulate unoccupied condition. Verify and document the following:

a. Nonexempt lighting turns off.

b. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

E. Daylight Responsive Controls:

1. Where daylight responsive controls are provided, the following shall be verified:
    a. Control devices have been properly located, field calibrated and set for accurate set points and threshold light levels.
    b. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
    c. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.

F. Documentation Requirements:
1. Documents certifying that the lighting controls meet documented performance criteria of the IECC are to be provided to the building owner within 90 days from the date of receipt of the certificate of occupancy.

3.7 TRAINING

A. The lighting control system manufacturer or the manufacturer's authorized representative shall conduct formal training for all users of the automatic lighting control systems.

END OF SECTION 260923

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. All work specified within this Section shall be for the main electric service entrance switchboard at Pawling Elementary School.

B. Section Includes:

1. Service and distribution switchboard rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.2 SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

2. Switchboard overcurrent protection device types will be coordinated with the findings and setting recommendations of the associated Short Circuit/Coordination Study and Arc-Flash Hazard Analysis – as specified in Section Nos. 260573 – Electrical Power System Study. Final approval of switchboard submittal is contingent upon review and approval of the Short Circuit/Coordination Study/Arc-Flash Hazard Analysis.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.

4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. If applicable, detail utility company's metering provisions with indication of approval by utility company.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Utility company approval for components subject to their specifications. Forward complete switchboard submittal to:

New York State Electric and Gas
35 Milan Road Brewster, NY 10509
Attn: William Pedro III
Phone: (845)- 490-1778 Cell, (585)-484-2949 Office
Wpedro3@nyseg.com

D. Qualification Data: For Installer and testing agency.

E. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in other sections, include the following:
   a. Routine maintenance requirements for switchboards and all installed components.
   b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards – incorporating all recommendations put forth in the final Short Circuit/Coordination Study and Arc-Flash Hazard Analysis. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

1.5 QUALITY ASSURANCE

A. Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:

1. Ground Fault Circuit Protection UL 1053.
2. QMQB Operators UL E1818.
3. Switchboards NEMA Standards PB-2, PB-2.1, PB-2.2; UL 891 and UL Service Entrance Label.
4. Meters ANSI Specification C 39.1.
5. ANSI C37.13.
6. ANSI C37.51.
7. NETA Testing Requirements.
8. Molded Case Circuit Breakers UL 489 and NEMA AB1.
9. NRTL labeled for service equipment.

B. Each switchboard as a complete and finished product shall receive a single integrated equipment rating by the manufacturer. The integrated equipment short-circuit rating shall certify that all equipment is capable of withstanding the thermal and magnetic stress of a fault equal to the value calculated by the Contractor/manufacturer's coordination study. Such rating shall be established by actual tests by the manufacturer on similar equipment. This certification shall be permanently affixed to each switchboard. Test data shall be submitted to the Engineer at the time of submission of Submittal Drawings.

C. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, obstacles and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and (temporary) HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not exceeding 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and

other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, bus work, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

A. Eaton, General Electric, Siemens, or Square D.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Switchboards described in this article include service and distribution types most commonly applied.

F. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Individually mounted.
2. Branch Devices: Panel (group) mounted.
3. Sections front and rear aligned.

G. Nominal System Voltage: as indicated on the drawings.

H. Main-Bus Continuous: as indicated on the drawings.

I. Indoor Enclosures: Steel, NEMA 250, Type 2.

J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

K. Barriers: Between adjacent switchboard sections.

L. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

M. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

N. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

O. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.

2. Pull box across the entire top of switchboard.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

P. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity.
3. Copper feeder circuit-breaker line connections.
4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.

5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:
   a. Isolate neutral bus from incoming neutral conductors.
   b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

Q. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.2 SURGE PROTECTION DEVICES

A. SPDs: Comply with UL 1449, Type 1.

B. Features and Accessories:

1. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
2. Indicator light display for protection status.
3. Form-C contacts rated at 2 A and 24-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
4. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 208Y/120 V.
3. Line to Line: 1000 V for 208Y/120 V.

E. SCCR: Equal or exceed 200 kA.

F. INominal Rating: 20 kA.

2.3 OVERCURRENT PROTECTIVE DEVICES

A. Feeder Circuit Breakers:

1. Thermal magnetic molded case circuit breakers shall:
    a. Molded case circuit breakers shall have integral and instantaneous thermal magnetic trip in each pole. Each molded case circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached. Provide adjustable trip setting for circuit breaker; adjustable instantaneous trip circuit branches; or magnetic trip element with front-mounted field adjustable trip setting.
    b. Circuit breaker(s) shall be standard interrupting. Ampere ratings shall be as shown on the Contract Documents. Manufacturer shall submit one (1) set of published Ip and I^2t let-through curves (as required by UL) to the Owner.

2. Molded-Case Circuit Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Suitable for number, size, trip ratings, and conductor material.
    c. Ground-Fault Circuit Protection (when provided): Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    d. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified.
    e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    f. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    g. Auxiliary Contacts: Two (2) SPDT switches with “a” and “b” contacts; “a” contacts mimic circuit-breaker contacts, “b” contacts operate in reverse of circuit-breaker contacts.
    h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in “OFF” position.

3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Programmable Instantaneous trip.
    b. Programmable Long and short-time pickup levels.

c. Programmable Long and short-time time delay with selectable flat or I^2t curve shaping, and zone selective interlocking.
d. Programmable Ground-fault pickup level, time delay, and I^2t response with selectable flat or I^2t curve shaping.

B. Main Circuit Breaker
1. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
a. Fixed circuit-breaker mounting.
b. Two-step, stored-energy closing.
c. Full-function, microprocessor-based trip units with interchangeable rating plug and trip indicators.
d. Programmable Instantaneous trip.
e. Programmable Long and short-time pickup levels.
f. Programmable Long and short-time time delay with selectable flat or I^2t curve shaping, and zone selective interlocking.
g. Programmable Ground-fault pickup level, time delay, and I^2t response with selectable flat or I^2t curve shaping.
2. The trip unit shall be provided with an Arcflash Reduction Maintenance System Technology capability. The Arcflash Reduction Maintenance System shall allow the operator to enable a maintenance mode using a 5 position switch which enables a preset accelerated instantaneous override trip to reduce arc flash energy. A blue LED on the trip unit shall indicate the trip unit is in the maintenance mode.
3. Remote trip indication and control.
4. Communication Capability: Web enabled integral Ethernet communication module and embedded Web server with factory-configured Web pages (HTML file format).
5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.4 INSTRUMENTATION

A. Multifunction Digital-Metering/Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Billing Meters Accuracy: 0.2 percent of reading, complying with ANSI C12.1 and ANSI C12.20.

2. Ambient Temperature: Minus 22 deg F to plus 158 deg F (Minus 30 deg C to plus 70 deg C). Humidity: Zero to 95 percent, noncondensing.

3. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

4. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.

5. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.

6. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
   a. Phase Currents, Each Phase: Plus or minus 0.2 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.2 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.2 percent.
   d. Megawatts: Plus or minus 1 percent.Megavars: Plus or minus 1 percent.
   e. Power Factor: Plus or minus 1 percent.
   f. Frequency: Plus or minus 0.1 percent.
   g. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
   h. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
   i. Contact devices to operate remote impulse-totalizing demand meter.
7. Mounting: Display and control unit flush or semiflush mounted in main circuit breaker compartment door.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.6 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified elsewhere in the project specifications.

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install filler plates in unused spaces of panel-mounted sections.

F. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

G. Comply with NECA 1.

3.3 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

D. Extend insulated grounding electrode cable to building water main, building structural steel and provided grounding electrodes. Support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with the project specification requirements for identification.

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with the project specifications.

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with the project specifications.

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. Acceptance Testing:
   a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
   b. Test continuity of each circuit.
2. Ground-fault protection of equipment for service equipment per NFPA 70 - 2017 Edition.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
7. Determine the following by primary current injection:
   a. Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   b. Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   c. Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   d. Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
   e. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
   f. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
   g. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free,

anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

h. Verify operation of charging mechanism. Investigate units that do not function as designed.

8. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in the findings and setting recommendations of the associated Short Circuit/Coordination Study and Arc-Flash Hazard Analysis – as specified in Section Nos. 260573.13, 260573.16 and 260573.19 furnished by the Electrical Contractor.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. MCCB: Molded-case circuit breaker.

E. SPD: Surge protective device.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard (where applicable).

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

C. Qualification Data: For testing agency.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in other sections, include the following:
   a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction manager and Owner no fewer than five business days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from the date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: 3 years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 3R.
   c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:
   a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
   a. Plating shall run entire length of bus.
   b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate on load side of main device unless otherwise noted on plans.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

I. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent or what is shown on contract drawings (whichever value is greater).

K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2.

2.3 DISTRIBUTION PANELBOARDS

A. Approved manufactures:
   1. Square D Co. I-Line
   2. Siemens: Type P4/P5
   3. General Electric: Spectra Series

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

   1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

   1. Internal Control-Power Source: Control-Power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Approved manufacturers:
   1. Square D
   2. Siemens
   3. General Electric

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Electronic Trip Circuit Breakers:

a. 100 percent rated
b. RMS sensing.
c. Field-replaceable rating plug or electronic trip.
d. Digital display of settings, trip targets, and indicated metering displays.
e. Multi-button keypad to access programmable functions and monitored data.
f. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
g. Integral test jack for connection to portable test set or laptop computer.
h. Field-Adjustable Settings:
1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long and short time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
5. Subfeed Circuit Breakers: Vertically mounted.
6. MCCB Features and Accessories:
a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.

d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Communication Capability: Circuit-breaker-mounted or integral communication module with functions and features compatible with power monitoring and control system.
h. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
m. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
n. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:

1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim at a height so that the operating handle of the top-most switch or circuit breaker, in ON position, is not higher than 79 inches (2000 mm) above finished floor or grade, unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

J. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

L. Install filler plates in unused spaces.

M. Stub four 1-inch empty conduits from recessed mounted panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with the project specification requirements for identification.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with the project specifications.

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with the project specifications.

E. Install warning signs complying with requirements of the project specifications.

3.4 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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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 and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 “Coordination Studies.”

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Owner.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.
5. Update panelboard directories accordingly, and provide updated directories to Owner within five business days of load balancing.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard-Grade receptacles.
2. GFCI receptacles.
3. Twist-locking receptacles.
4. Toggle switches.
5. Wall plates.
6. Floor service outlets.
7. Poke-through assemblies
8. Exterior power device pedestals.

1.2 SUBMITTALS

A. Product Data: For each type of product. Highlight exact model being proposed in each submittal.

1.3 WARRANTY

A. Provide five (5) year manufacturer's warranty on all components.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES

A. Simplex or Duplex Receptacles: 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with NEMA WD 1, UL498, and FS W-C-596.

B. Weather-Resistant Duplex Receptacles: 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with NEMA WD 1, UL498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.3 GFCI RECEPTACLES

A. Duplex GFCI Receptacles: 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons. Two pole, three wire, and self-grounding, Feed Through type.
2. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
3. GFCI shall interrupt ground leak currents between 4-6 mA with a tripping time of .025 seconds.
4. Configuration: NEMA WD 6, Configuration 5-20R.
5. Standards: Comply with NEMA WD 1, UL498, UL 943 Class A, and FS W-C-596.

2.4 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Convenience Receptacles: comply with NEMA WD 1, NEMA WD 6 Configurations and UL 498. Refer to contract drawings for voltage rating, ampere rating and plug configuration.

2.5 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A, Single pole:

C. Key-Operated Switches: 120/277 V, 20 A.

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

E. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: As selected by the Architect.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift gasketed cover, and listed and labeled for use in wet and damp locations (Mechanical rooms, pool rooms, garages etc).

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FLOOR SERVICE FITTINGS

A. Acceptable Manufacturers: Hubbell Inc, Legrand North America LLC and Leviton Manufacturing Co.

B. Type: Modular, flush-type or flap-type, dual-service units suitable for wiring method used.

C. Compartments: Barrier separates power from voice and data communication cabling.

D. Service Plate: Rectangular, die-cast aluminum with satin finish.

E. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

F. Data Communication Outlet: Blank cover with bushed cable opening.

2.9 POKE-THROUGH ASSEMBLIES

A. Acceptable Manufacturers: Hubbell Inc, Legrand North America LLC and Leviton Manufacturing Co.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Type as indicated on the drawings.
4. Size: Selected to fit nominal 3-inch (75-mm) or 4-inch (100-mm) cored holes in floor and matched to floor thickness. Core hole size as indicated on the drawings.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 3-inch (75-mm) or 4-inch (100-mm) cored openings and reestablish fire rating of floor.

2.10 DEVICE FINISHES

A. Device Color:

1. All normal Wiring Devices: As selected by Architect unless otherwise indicated.

2.11 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pass & Seymour/Legrand.
2. Hubbell
3. Leviton

2.12 EXTERIOR POWER DEVICE PEDESTALS

A. 5.00" x 2.50" x 24" high one gang hinged top outlet box with integral base. 14 gauge stainless steel pedestal and cover (welded to pedestal). 7 gauge stainless steel baseplate (welded to pedestal).
   1. Basis of Design: Pedoc Power Solutions Model # 1P24-C-V-G.
   2. UL Listed, NEMA 3R – suitable for wet locations while in use - rated enclosure, 20 amp, 120 volt.
   3. Provided with integral ground studs.
   4. Hinged cover lockable while in use.
      5. Open base for conduit entries: (2) – 1.0" maximum each.
      6. Removable one gang device mounting insert plate: (1) – 20 amp, GFCI duplex receptacle.
      7. Base mounting hardware: (4) – anchors, washers and acorn nuts.
      8. Painted Gray finish.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated. See table below for refence.

TYPICAL MOUNTING HEIGHTS	
DEVICE	**MOUNTING HEIGHT**
Wall switches, card readers	48 inches above finished floor to center
Receptacle outlets, data outlets, CATV outlets	18 inches above finished floor to center
Receptacle outlets – above counter	42 inches above finished floor to center, or 8 inches to center above countertops

B. Coordination with Other Trades:

   1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles 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.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

I. Switch Installation:

1. Install all switches vertically with the "ON" position on top, unless otherwise noted or specified.
2. Where switches are indicated near doors, corner walls, etc. install not less than two (2) inches and not more than twelve (12) inches from the trim.
3. Carefully coordinate location of switches to insure locations are at the strike side of the doors.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

B. Swab all conduits and outlet boxes clear of moisture.

C. Do not combine GFCI protected circuits with other circuits in the same raceway: only one (1) GFCI circuit per raceway.

D. Do not substitute GFCI circuit breakers for GFCI receptacles.

E. All GFCI receptacles shall be installed in a ready accessible location per the NEC.

3.3 EXTERIOR POWER DEVICE PEDESTALS

A. Provide roof curb for mounting of pedestal base with (2) – 1" conduit entry attachments oriented per manufacturer's installation specifications.

B. Attach branch circuit raceways through roof structure to base.

C. Attach pedestal to base. Provide connection of wiring devices as indicated on the Drawings.

3.4 IDENTIFICATION

A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.5 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Wiring device will be considered defective if it does not pass tests and inspections.

3.6 SPARE PARTS

A. Provide Five (5) spare devices for each type used on the project. Turn over to owner after project completion.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
    a. Enclosed controllers.
    b. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
5. Coordination charts and tables and related data.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Bussmann
2. Mersen
3. Littelfuse

B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Motor Branch Circuits: Class RK1, time delay.
   2. Other Branch Circuits: Class RK1, time delay.
   3. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Approved manufacturers:
1. Square D
2. Siemens
3. General Electric

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Manufacturer shall be the same as the switchboards and panelboards.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three or six pole. Provide six pole for connection to motors requiring six motor leads.
3. 600-V ac.
4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
6. Amperage rating as indicated on the drawings.

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 neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and copper conductors.
5. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

A. Manufacturer shall be the same as the switchboards and panelboards.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 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. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 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. Provide six pole switch for connection to motors requiring six motor leads.

D. Refer to drawings for amperage rating of switch(es).

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and copper conductors.
5. Service-Rated Switches: Labeled for use as service equipment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturer shall be the same as the switchboards and panelboards.

B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.

E. MCCBs shall be equipped with a device for locking in the isolated position.

F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.

G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

L. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

M. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.5 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (NEMA 250 Types 3R, 12) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure

cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain code required workspace clearances and required clearances for equipment access doors and panels, regardless of location indicated on the drawings.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in the Coordination studies, required per specification section 260573.16 and furnished by the Electrical Contractor.

END OF SECTION 262816

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of LED luminaires:

1. Lighting Fixtures.
2. Materials.
3. Finishes.
4. Fixture support.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Refer to the Lighting Fixture Schedule on the drawings for the specified fixtures and options.

2.2 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standards:

1. ENERGY STAR certified.
2. California Title 24 compliant.
3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
5. UL Listing: Listed for damp location.
6. Recessed luminaires shall comply with NEMA LE 4.

C. CRI as indicated on the drawings. CCT as indicated on the drawings.

D. Rated lamp life of minimum 50,000 hours to L80.

E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:
   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter, shape, size, wattage, and coating.
   c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with minimum two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
2. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Refer to Lighting Fixture Schedule on the drawings for the specified fixtures and options.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

F. Bulb Shape: Complying with ANSI C79.1.

G. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.

1. Emergency Connection: Operate lamp(s) continuously full lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
    b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
    c. Humidity: More than 95 percent (condensing).
    d. Altitude: Exceeding 3300 feet.
4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires: as indicated on the drawings.

C. Emergency Lighting Unit: as indicated on the drawings.

D. Remote Emergency Lighting Units: as indicated on the drawings.

2.4 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LED; 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.5 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Housings:

1. As indicated on the drawings.

D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.6 METAL FINISHES

A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

D. Wall-Mounted Luminaire Support:

1. Do not attach luminaires directly to gypsum board.

E. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.

2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

END OF SECTION 265219

SECTION 265619 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    a. IES LM-79 and IES LM-80 documentation.
    b. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

6. Photoelectric relays.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.4 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.6 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Engineer prior to the start of luminaire installation.

1.7 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

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

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Minimum five (5) years from date of Substantial Completion, inclusive of LED light engines and power components, metal parts, housings and finishes.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Lamp base complying with ANSI C81.61 or IEC 60061-1.

E. Bulb shape complying with ANSI C79.1.

F. CRI of minimum 70. CCT of approx. 4000 K.

G. L90 lamp life of minimum 100,000 hours.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Internal driver.

J. Nominal Operating Voltage: as indicated on the drawings.

K. In-line Fusing: Separate in-line fuse for each luminaire.

L. Lamp Rating: Lamp marked for outdoor use.

M. Source Limitations: Obtain luminaires from single source from a single manufacturer.

2.2 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc (16 to 32 lx) and off at 4.5 to 10 fc (48 to 108 lx) with 15-second minimum time delay. Relay shall have directional lens in front of photocell to prevent artificial light sources from causing false turnoff.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.3 LUMINAIRE TYPES

A. Area and Site:

1. As indicated on the drawings.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum, stainless steel or epoxy-coated steel. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Match finish process and color of pole and support materials.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

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

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.3 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

a. IES LM-5.
b. IES LM-50.
c. IES LM-64.
d. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

END OF SECTION 265619

SECTION 270310 - COMMUNICATIONS CABLING WORK - GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 INTENT

A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.3 CONFLICTS

A. If a conflict appears between the Drawings and the Specifications, the Contractor is to contact the Engineer for clarification. In the absence of a clarification by the Engineer, the Contractor must install his work in accordance with the more stringent application.

1.4 DEFINITIONS

A. Provide: Furnish, install and connect.
B. Furnish: Supply material only.
C. EXR: Existing to remain.

1.5 SCOPE OF WORK

A. Contractor shall do all work, furnish all labor, tools and equipment necessary for all the Cabling work all as indicated on the drawings and specified herein.

1. Provide and install new data cables as indicated on the plans for new Wireless access point and Future Security camera locations

2. Remove the existing wireless access points where indicated on plans and install new owner supplied access point in the same location. Reconnect the existing attachment cable. Work with the districts Network contractor to provide proper documentation of the access point serial number and

room it is installed in.

3. Provide surge suppression on the new exterior data drops for future exterior security camera as indicated on the plans.

4. Perform all removals as indicated on plans. Provide storage for devices indicated to be protected and stored for reinstallation in new work

5. Reinstall existing projectors as indicated on plans. Provide new ceiling mount for projector as indicated.

B. General:

1. All cutting and patching.
2. Coordinate with other trades and Owner for all installations.
3. Where indicated, install cable in tray or raceways. If not in tray then provide J-hook supports to building structure.

C. Copper Cable:

1. Preprinted cable markers.
2. Install and terminate copper cables.
3. All copper interconnect and distribution equipment.

D. Equipment:

1. Room network connectors.
2. Wire closet racks and accessories.
3. File server racks and accessories.
4. Wire management devices.
5. Patch panels with identification.

E. Installation:

1. Where indicated this Contractor shall provide surface raceway and conduit as required for installation of network cabling.

F. Documentation:

1. Detailed riser diagrams indicating all cable identification numbers.
2. Provide specific appropriate drawings in each wire closet.
3. Provide required quantity of project records.

G. Testing:

1. Copper testing.
2. Submit test results documentation to Engineer for review.

H. Training:

1. Provide system familiarization and training periods indicated in specification.

1.6 CONTINUITY OF UTILITY SERVICES

A. Utility service operate continuously and without interruption. Changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. Contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.7 CODES AND STANDARDS

A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:

1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
   a) 2020 International Building Code
   b) 2020 International Existing Building Code
   c) 2020 International Fire Code
2. 2020 Supplement to the New York State Energy Conservation Construction Code including all applicable amendments to the following:
   a) 2020 International Energy Conservation Code
   b) 2013 ASHRAE 90.1
3. 2020 Uniform Code Supplement (May 12, 2020)
4. Conform to requirements of NEMA.
5. Bear label of Underwriters Laboratories, Inc.
6. National Electrical Code NFPA Article 70, latest edition.
7. Local Utility Standards
8. Shall be in accordance with other standards as listed elsewhere in the specification.

1.8 SUBMITTALS & SUBMISSION REQUIREMENTS

A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and as indicated in each specification section. All

submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.

1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed.
2. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
3. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page(s) shall also indicate project name and building name.
4. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usages, model numbers, construction materials, performance, data, etc.
5. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
6. The contractor shall insure that dimensions of equipment to be used conform to the space allocated for the equipment on the drawings.
7. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.

B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.

C. Substitutions:

1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.
3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.

4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.

5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.9 CUTTING AND PATCHING

A. Contractor shall bear the cost of all cutting and patching required by and for the installation of new work and as required by removal work. Contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.

B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

C. Changes, omissions or errors in communications cabling work require cutting, patching or making alterations in any portion of new construction, such work will be performed by the GC.

D. Cutting and Patching of roof surfaces and structures shall only be performed by a qualified contractor, as approved by the Architect. The work of this contract shall bear the cost of above mentioned cutting and patching.

E. This contractor shall furnish lintels, sized to accommodate structure above opening, where cutting and patching is to be performed on load bearing walls. Contractor shall obtain written approval for all lintels prior to installation.

1.10 FIELD INSPECTION

A. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.11 INSTRUCTION SERVICES AND MANUALS

A. Training Session: A training session shall be held for each system and/or item listed below:

Item	Description	Training Hours For Each Bldg
1.	Copper Cable Infrastructure	2
2.	Computer Conduit System and Components	2

B. The instruction shall include the following types of information:

1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally require

C. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

D. Manuals:

1. Submit Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.
   a) For projects containing multiple buildings, manuals shall be submitted separately for each building.

2. Provide a typed schedule of vendors, part numbers, contact numbers for each piece of equipment supplied under this Contract.

1.12 PERMITS, CERTIFICATES AND FEES

A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the base bid amount.

1. All required applications and permits to begin work
2. Certificate of inspection including Third-Party Agency.
3. All municipal connection charges
4. All local utility charges (power, telephone, cable, etc.)

1.13 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

A. All removed equipment shall be removed from the site and properly disposed of.

1.14 GUARANTEE

A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Final acceptance will be determined by Owner's Representative on a per building basis. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.15 INSTALLATION

A. Contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.

B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.

C. Layout of equipment, accessories and cabling systems is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. Dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.

D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.16 TESTING AND INSPECTION

A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing.

B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.

D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.

1.17 RECORD DOCUMENTS

A. When required by general conditions, or as required elsewhere in specification, or other Division 1 Sections, this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.

B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.18 IDENTIFICATION AND NAMEPLATES

A. Provide engraved plastic Nameplates with Epoxy style adhesive to equipment, data and coax locations furnished under this contract. Labels shall have black background, white letters; minimum letter height 3/8" high. Punch tape type labels are not acceptable. Contractor to replace damaged nameplates as required.

1.19 PENETRATIONS THRU FIRE AND SMOKE RATED CONSTRUCTION

A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.

B. All electrical penetrations through walls, floors, etc. shall be conduit sleeved.

C. All conduit penetrations through fire and smoke rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This Contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.20 CONFINED SPACES

A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.

B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

END OF SECTION 270310

SECTION 270315 - COMMUNICATIONS CABLING SPECIAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.2 SUBMITTALS

A. Contractor qualifications.

B. Test report format and blank forms.

C. Complete riser diagram.

D. Test report booklets with all failed cables shall be flagged with a tab on the test report.

E. Written certificate of completion.

1.3 CONTRACTOR'S QUALIFICATIONS

A. Installer shall certify to the Engineer's satisfaction, that they have the necessary knowledge and experience to successfully complete the specified work prior to starting any work. Contractor shall submit to Architect and/or Engineer the requirements listed below.

B. Contractor shall have on staff for the previous 12 months, prior to the bid date a Registered Communications Distribution Designer. Submit a copy of current registration information and date of original certification for RCDD.

C. Installers shall have minimum (5) years experience with computer network installations.

D. Installer shall provide to Architect/Engineer, a reference list of (5) recently completed projects of similar size and scope. Reference list shall include detailed description of installers actual work responsibilities. Reference list shall also include contact persons and telephone number for each project.

E. Submit certifications or similar documents indicating technician experience levels regarding communications and computer networking experience.

1.4 PROJECT STANDARDS

A. All equipment and installation methods shall conform to nationally recognized standards.

B. All work shall be in compliance with IEEE Standard 802.

C. All cabling and all components shall be in compliance with EIA/TIA 568, ISO9001, IEC 11801 latest revision.

D. All cabling shall utilize pair to pair and power sum testing methods.

E. Selected installation methods specified herein may include more specific requirements than listed in the above referenced standards. Contractor is instructed to comply with both minimum standards (such as listed above) and any additional items specifically required in these specification sections relating to Computer Network Cabling.

F. All Enhanced Category 6 cable connectors and terminations will comply with EIA/TIA 568, ISO9001 and IEC 11801 Standards; Type B.

1.5 ACCEPTANCE TESTING

A. General: The entire network cabling system shall be fully tested by a qualified Contractor.

B. Testing procedures shall comply with the latest versions of applicable IEEE & EIA/TIA Standards, this section, and specific requirements of other sections of this specification.

C. Architect, Engineer and Owner shall be notified (2) weeks prior to commencement of testing. All testing shall be done in the presence of the Owner's Representative or test will be rejected.

1.6 TESTING REPORTS

A. Contractor shall submit written test reports for all types of cables and on each individual cable. All individual test reports shall be bound into a booklet form. Contractor shall submit (1) paper copy of final testing report to Architect/Engineer and all data on CD. For multiple buildings provide (1) copy for each building involved in project.

B. Prior to the start of work, Contractor shall submit test booklet format and blank test report forms for Engineer approval.

C. Report booklet shall include final riser diagrams with cable identification numbers.

D. Provide cover sheet per building including all nodes and associated test results. Cover sheet shall include Building Name, Wiring Closet Number, Type of Cable, Room Number, Room Name, Result (Pass or Fail), Length, etc.

E. All individual cable test result sheets shall indicate the following general information:

1. Building Name
2. Testing Company
3. Test Date
4. Type of Test
5. Software Version
6. Cable Identification Number
7. Type of Cable
8. Rack Number
9. Local Building Location
10. Operator's Signature (Testing Company)
11. Test Instrument Calibration Status
12. Witness Signature (Owner's Representative)
13. Test Instrument Set Up Values
14. Pass/Fail Indication
15. Fiber optic test report shall include the fiber strand color on each test report and fiber patch panel location for each end.

F. Copper Cable:

1. Test result sheet shall indicate, as a minimum, the following information:
2. Test results shall be listed for each individual conductor pair in each cable.
3. Individual test report swept out to 350 MHz for each reel of cable with ACR values for power sum and pair to pair ratings.
4. Cable Testing:
   a) Required Testing Instruments: all copper cable runs are to be tested by the Contractor using a Fluke # DSX-5000; or equal.
5. Tests shall include the following:
   a) Wiremap
   b) Length
   c) Attenuation to Crosstalk (ACR) Power Sum
   d) Return Loss (RL)
   e) Near End Crosstalk (NEXT) Power Sum
   f) Equal Level Far-End Crosstalk (ELFEXT

g) Power Sum Attenuation

6. Cable identification number, conductor pair number.

G. Fiber Optic Cable:

1. Test results shall be listed for all active and unterminated dark strands in each cable.
2. Test results shall include reflectometer (OTDR) graphical trace for entire cable length. Trace shall be magnified to largest scale possible. Testing for multi strands shall be done at both 850 and 1300 nm wave lengths. Single mode fibers shall be tested at both 1310 and 1550 nm wave lengths.
3. Light sources shall operate within the ranges of 805 ± 30 nm or 1300 ± 20 nm. Testing and instruments shall comply with EIA/TIA-526-14. Power meters shall be calibrated and traceable to the National Bureau of Standards.

H. Link Attenuation:

1. Link attenuation shall be based on the connectivity requirements of TIA/EIA-568B.1 and the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14-A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user should follow the procedures established by these standards to accurately conduct performance testing.
2. The reference jumper should be wrapped in five non-overlapping turns around a smooth round mandrel (rod) during the reference calibration of the source to the detector and for all loss measurements. The mandrel diameter shall be specified as in Table 11-15 of TIA/EIA-568B.1.
3. The horizontal optical fiber cabling link segments should only be tested at one wavelength. The horizontal link shall be tested at 850 nm or 1300 nm in one direction in accordance with TIA/EIA-526-14-A, Method B, One Reference Jumper. The attenuation test results shall be less than 2.0 dB.
4. The backbone optical fiber cabling link segment shall be tested in at least one direction at both operating wavelengths to account for attenuation deltas associated with wavelength. Singlemode backbone links should be tested at 1310 nm and 1550 nm in accordance with TIA/EIA-526-7 Method A.1 One Reference Jumper. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with TIA/EIA-526-14A, Method B, One Reference Jumper. The following link attenuation equation should be used to determine acceptance values based upon the component requirements of TIA/EIA-568B.3 at each of the applicable wavelengths:
   a) Link Attenuation = Cable Attenuation + Connector Insertion Loss + Splice Insertion Loss

5. A centralized optical fiber cabling link shall be tested at 850 nm or 1300 nm in one direction in accordance with TIA/EIA-526-14A, Method B, One Reference Jumper. The attenuation results shall be less than 3.3 dB.
6. For centralized optical fiber cabling link segments implemented in conjunction with open office cabling with a consolidation point, the attenuation results shall be less than 4.1 dB.

I. Reel Testing:

1. All fiber shall be tested on original shipping reel prior to installation.
2. Perform the following tests on the installed fiber optic cable systems:
3. End to End Attenuation Test: Test and record end to end optical power loss between all termination point segments and both listed wave lengths. Test reports shall indicate wave lengths, segment power budgets, actual test values.

J. OTDR Testing:

1. Perform Optical Time Domain Reflectometer (OTDR) testing to identify attenuation and locations of individual components. OTDR shall be capable of resolving components less than 13 ft. apart.
2. Testing report shall include printed individual graphical signature traces for each strand.
3. OTDR testing shall include the following:
   a) Fiber loss at both listed wave lengths.
   b) Detect fault points (if any).
   c) Measure overall length.
   d) Splice losses.
   e) Connector losses.
   f) High resolution OTDR trace at connectors.

K. Transmitter/Receiver Level Testing: After installation of network electronics, test device transmit levels at source, then test receiver power levels at opposite end of fiber strand. Verify received power level is within operating level of network devices.

L. Certificate of Completion:

1. The Contractor shall certify in writing that the entire network cabling systems is 100% complete, properly installed, in full compliance with IEEE & EIA/TIA Standards, fully tested, and that all documentation has been transmitted to the Owner or his representative.
2. The certificate shall state the Contractor's warrantee for completed work.

END OF SECTION 270315

SECTION 270528 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

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. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Metallic surface pathways.
4. Hooks.
5. Boxes, enclosures, and cabinets.

1.3 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Boxes, enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. IMC: Comply with ANSI C80.6 and UL 1242.

E. EMT: Comply with ANSI C80.3 and UL 797.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:

a. Material: Steel.
b. Type: Set screw.

G. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Finish: Manufacturer's standard enamel finish in color selected by Architect.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.4 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized steel.

E. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Hinged-Cover Enclosures: Comply with UL 50 and 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. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

F. 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 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:

   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical rooms.
   d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT or innerduct.
5. Damp or Wet Locations: GRC or IMC].
6. Pathways for Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway: EMT.

7. Pathways for Concealed General-Purpose Distribution of Communications Cable: General-use, communications-cable pathway: EMT.

B. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.

C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. EMT: Use set-screw steel fittings. Comply with NEMA FB 2.10.

D. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 105.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

S. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.

3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

X. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 270528

SECTION 271100 - NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 GENERAL

A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.3 QUALITY ASSURANCE

A. All equipment rooms shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the Contract Documents shall be subject to the control and approval of the Owners representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.

B. Materials and work specified herein shall comply with the applicable requirements of:

1. ANSI/TIA/EIA-568B.x
2. NECA/BICSI 568-2001
3. ANSI/TIA/EIA-569A -x
4. ANSI/TIA/EIA-606-A
5. TIA/EIA-J-STD-037
6. Underwriters Laboratory
7. Federal Communications Commission
8. NFPA 70 – 2014
9. BICSI "Telecommunications Distribution Method Manual", current edition.
10. NEMA-250
11. EIA 310-D

1.4 SUBMITTALS

A. Installers training certifications for all installers.

B. Schedule of all materials. Schedule shall indicate device model numbers, quantity required, locations used in project, etc. in spreadsheet form.

C. Descriptive product data on all equipment.

D. Wiring and equipment rack construction and accessories.

E. Wiring and equipment rack arrangement drawings indicating all internal equipment points including node identification numbers, and major internal cable routing.

F. Cable Management.

PART 2 - PRODUCTS

2.1 WIRE HANGERS

A. J-Hooks: Extra wide J-hook type hanger with velcro, 2" for up to (84) cables, CPI Chatsworth Part #31422-801 for 2" J-hook. Located every 4'-0" as needed for cables run without channel tray. Supply appropriate upper hanger attachment accessories as required; beam clamps or concrete anchors, CPI Chatsworth Products; or equal.

1. Provide Panduit strap around bottom of J-hook and thru closure holes to contain cables.

2.2 WIRE MANAGEMENT

A. Enclosure Cable Management (Front and Side):
1. Wire Management Panels: 19" rack mount panduit duct on front and back both with covers, strain relief clips at all ends, Part #WMP1, Panduit Co. Network Systems Division; or equal.
2. Open Rack Cable Management (Front and Side): Add Panduit Management to all WC double data racks.
a. Front and Rear (horizontal) Model #WMPH2
b. Vertical (side) Full Length Model #WMPVHC45E
c. Center (side) Full Length Model #WMPVHC45E with WMPVCBE

2.3 WIRE AND EQUIPMENT RACKS

A. Schedule of Equipment Enclosures:

1. See drawing floor plans for locations; riser and detail sheets for individual rack configurations.

2. NOTE: Provide all components listed. All components listed are NOT included with the Base Part numbers.

2.4 SPECIALTY NETWORK EQUIPMENT

A. Termination and Testing Devices: Provide (2) of each item listed below and turn over to Owner.

1. Punch Down Tool: Harris/Dracon impact tool Model #10054-000. Provide (3) 110/88 blades Model #10176-000; or approved equal.

2. Combination Telecom Termination Kit: Ideal Industries combination telecom termination kit Model #33-704; or approved equal.

3. Cable Tester: Tripp Lite Cable Tester Model #TL-N044000-R; or approved equal.

B. Wireless Access Point Ceiling Enclosure (WAPE-1): Provide a ceiling mounted enclosure with all mounting hardware required for a grid ceiling system. Enclosure shall have a white powder coat finish, security lock. Enclosure size 12"x12"x3-7/8" deep. Wiremold #WAPENCL; or approved equal.

PART 3 - EXECUTION

3.1 WIRING CLOSETS

A. Where wiring and/or equipment enclosures are shown adjacent on drawings, provide interconnecting kits; do not provide intermediate side walls.

B. Gaps or open joints at enclosure interconnection are not permitted.

C. After installation of all enclosures remove transportation eye bolts from top of enclosures and replace with (4) roof panel bolts.

D. Coordinate exact location of wiring closets. Racks shall be located directly above cable tray.

E. After installation of rough wiring in enclosures, contractor shall completely clean and vacuum all interior surfaces of enclosures.

F. For final completion, contact Owner's Representative for final review of all data closets.

G. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.

H. Fire Stop all sleeves and conduit openings. Conduit openings shall be fire stopped after all cables have been tested.

END OF SECTION 27110

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.

B. Work specified in this section is included in the cabling contract.

C. This section shall include the following:

1. Category 6 and 6A cable
2. Patch Panels
3. Communications Faceplates
4. Termination Jacks

1.3 REFERENCES

A. The products and work herein specified shall comply with the current additions of the following publications and standards.

1. UL - Underwriter Laboratory
2. NEC – National Electric Code
   a) Article 725
   b) Article 770
   c) Article 800
3. NFPA – National Fire Protection Association
4. NECA - Standard of Installation
5. ANSI – American National Standards Institute
6. NEMA – National Electrical Manufactures Association
   a) Article 250
7. EIA – Electronic Industries Alliance
   a) ANSI/TIA/EIA-568-C.2.

b) ANSI/EIA/TIA 569B
c) ANSI/EIA/TIA 606A
d) ANSI-J-STD-607-A
e) ANSI/TIA/EIA-606-A

8. TIA – Telecommunications Industry Association
9. IEEE C2 National Electrical Safety Code
10. FCC - Federal Communications Commission
    a) CFR 68
11. BICSI – Building Industry Consulting Services International
    a) Distribution Methods Manual
    b) ANSK/NECA/BICSI 568
12. ISO/IEC 11801

B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 QUALITY ASSURANCE

A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.

B. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

D. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.5 SUBMITTALS

A. Provide manufactures cutsheets, specifications, and installation instructions for the products herein specified.

1. Category 6 cable

2. Category 6 Patch Panels
3. Communications Faceplates
4. Wall Phone Faceplates
5. Modular Jacks

B. Termination details for all cable types.

PART 2 – PRODUCTS

2.1 CATEGORY 6 100 OHM UNSHIELDED TWISTED PAIR CABLE

A. The horizontal balanced twisted pair cable shall exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.

B. Shall be independently verified to comply with ANSI/TIA/EIA-568-C.2.

C. An ISO 9002 Certified Manufacturer shall make the cable.

D. Cable shall be UL LISTED.

E. Cable shall be plenum rated

F. Physical Characteristics:

1. Shall be CMP (plenum rated) rated and meet applicable requirements of ANSI/ICEA S-80-576 and NEC.
2. Conductor shall be 23 AWG solid bare annealed copper.
3. Outer jacket colors shall be orange for security cameras, Blue for Data or voice outlets.
4. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.
5. The diameter of the insulated conductor shall be .023 in. maximum.
6. Shall consist of (4) 23 AWG twisted pairs.
7. Shall be suitable for the environment in which they are to be installed.
8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; 0
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.
10. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius

without jacket or insulation cracking.

G. Compliance

1. ANSI/TIA-568-C.2
2. U.L. 444
3. U.L. 1666
4. NFPA 262

H. Impendence - 100 Ohm +/- 15

I. Guaranteed Performance (db/100m)

1. Cable shall exhibit a minimum NEXT of:

Frequency MHz	NEXT
1.0	84.3
4.0	75.3
10.0	69.3
16.0	66.2
20.0	64.8
31.25	61.9
62.5	57.4
100.0	54.3
200	49.8
250	48.3
400	45.3
550	43.2

2. Cable shall exhibit Minimum ELFEXT of:

Frequency MHz	ELFEXT
1.0	76.8
4.0	64.8
10.0	56.8
16.0	52.7
20.0	50.8
31.25	46.9
62.5	40.9
100.0	36.8
200	30.8
250	28.8
400	24.8
550	22.0

3. Cable shall exhibit maximum Insertion loss of:

Frequency MHz	Insertion Loss
1.0	2.0
4.0	3.7
10.0	5.9
16.0	7.4
20.0	8.3
31.25	10.5
62.5	15.1
100.0	19.3
200	28.2
250	31.8
400	41.5
550	49.7

4. Cable shall exhibit minimum ACR minimum of::

Frequency MHz	ACR
1.0	80.3
4.0	69.5
10.0	61.4
16.0	56.8
20.0	54.4
31.25	49.4
62.5	40.3
100.0	33.0
200	19.6
250	14.5
300	9.9

5. Cable shall exhibit PSNEXT minimum of:

Frequency MHz	PSNEXT
1.0	82.3
4.0	73.3
10.0	67.3
16.0	64.2
20.0	62.8
31.25	59.9
62.5	55.4
100.0	52.3
200	47.8
250	46.3
400	43.3

6. Cable shall exhibit minimum return loss:

Frequency MHz	Return Loss
1	20.0
4	23.6
10	26.0
16	26.0
20	26.0
31.25	23.6
32.5	25.0
100	22.5
200	21.0
250	20.5
400	19.5
550	18.8

J. Design Make: Belden Data Twist 3613 non bonded

2.2 CATEGORY 6 CONNECTING HARDWARE

A. Category 6 compliant modular jacks

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6 cable

C. Physical Characteristics

1. Jacks shall be 8 position un-keyed
2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760" x 580")
3. Jack housings shall be high impact 94 V-0 rated thermoplastic
4. Jacks shall have a temperature rating of -10 ▪ C (14▪ F) to 60▪ C (140 ▪ F) in conformance with ANSI/TIA/EIA-568-A
5. Jacks shall utilize a 2 - layer printed circuit board to control NEXT
6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
7. Housing shall be ultrasonically welded for tamper resistance.
8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.
9. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.
10. Modular jack contact wires shall be formed flat for increased surface

contact with mated plugs.

11. Contacts shall be arranged on the PC board in 2 staggered arrays, one array has 6 contacts and the other array has 2 contacts.
12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
13. Contact Plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro-inch of nickel.
14. Jack termination shall follow the industry standard 110 IDC.
15. IDC contact termination towers shall be paired and angled at 29.5 degrees.
16. IDC contacts shall be laid out in staggered arrays of 4 sets of 2 contacts.
17. Jacks shall have a designation indicating Category 6 on the nose which can be plainly seen from the front of the faceplate. Bottom of jack shall have date code and an abbreviated catalog number.
18. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
19. 110 IDC shall utilize 100 micro-inch tin lead plated (60% tin/40%lead) over phosphor bronze over nickel.
20. Jacks shall terminate 22-26 AWG stranded or solid conductors.
21. Jacks shall terminate insulated conductors with outside diameters up to .050"
22. Jacks shall be compatible with single conductor 110 impact termination tools.
23. Jacks shall include translucent wire retention stuffer cap, that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.
24. Stuffer cap shall have a positive locking latch to provide conductor strain relief.
25. Stuffer cap used for wire termination with channel lock style pliers.
26. Jacks shall be compatible with TIA/EIA 606 color code labeling
27. Jacks shall accept snap on icons for identification or designation of applications.
28. Jacks shall be available in 6 colors for identification or designation of applications at the workstation or telecommunication room.
29. Jacks shall have universal wiring designation.
30. Jacks shall be marked with the T-568A wiring scheme.
31. Jacks shall have an attached color coded wiring instruction label housed between the IDC termination towers.
32. Jacks shall be manufactured in the USA
33. Jacks shall be designed for 100 Ohm UTP cable termination

34. Jacks shall be UL LISTED 1863 and CSA certified.
35. Jacks shall be made by an ISO 9002 Certified Manufacturer.

D. Design Make: Belden Cat6+

E. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Hubbell

2.3 CATEGORY 6A (625MHZ) 4-PAIR UNSHIELDED TWISTED PAIR CABLE

A. The horizontal balanced twisted pair cable shall exceed the Category 6A transmission characteristics per issue of ANSI/TIA/EIA 568-C.2 Category 6A. Tested to 625MHz.

B. Shall be comply with the following:

1. Category 6A - TIA 568.C.2
2. ISO/IEC 11801 ed 2.1 (2008) Class EA

C. An ISO 9002 Certified Manufacturer shall make the cable.

D. Cable shall be UL LISTED.

E. Physical Characteristics:

1. Cable shall be plenum rated and meet NFPA 262 Plenum Flame Test (UL910)(FT6).
2. Conductor shall be 23 AWG solid bare annealed copper.
3. Nominal Outside Diameter - 0.269 in.
4. Minimum Bend Radius/Minor Axis: 1.200 in.
5. Minimum Bend/Installation: 2.7 in.
6. Maximum Pulling Tension - 40 lbs.
7. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.
8. The color coding of pairs shall be:
   a) Pair 1 White/Blue Stripe & Blue
   b) Pair 2 White/Orange Stripe & Orange
   c) Pair 3 White/Green Stripe & Green
   d) Pair 4 White/Brown Stripe & Brown

F. Electrical Characteristics Overall

1. Capacitance (pF/ft) – 17.00
2. Nominal Velocity of Propagation: 68.00%
3. Maximum Delay (ns/100 m) - 537 @ 100MHz
4. Typical Delay Skew (ns/ft)- 35
5. Maximum Delay Skew (ns/100 m) – 45
6. Maximum Conductor DC Resistance @ 20°C (Ohm/100 m) – 7.4
7. Maximum Operating Voltage - UL: 300 V RMS
8. Maximum DCR Unbalanced @ 20°C (%) : 3.000

Electrical Characteristics (Continued)

Frequency (MHz)	Input (Unfitted) Imp. (Ohms)	Fitted Impedance	Min. PSACRF (dB)
1	100+/- 15	100+/- 10	68.8
4	100+/- 15	100+/- 10	56.8
8	100+/- 15	100+/- 10	50.7
10	100+/- 15	100+/- 10	48.8
16	100+/- 15	100+/- 10	44.7
20	100+/- 15	100+/- 10	42.8
25	100+/- 15	100+/- 10	40.8
31.25	100+/- 15	100+/- 10	38.9
62.5	100+/- 15	100+/- 10	32.9
100	100+/- 15	100+/- 10	28.8
200	100+/- 22	100+/- 10	22.8
250	100+/- 22	100+/- 10	20.8
300	100+/- 22	100+/- 10	19.3
350	100+/- 22	100+/- 10	17.9
400	100+/- 22	100+/- 10	16.8
450	100+/- 22	100+/- 10	15.7
500	100+/- 22	100+/- 10	14.8
550	100+/- 22	100+/- 10	14.0
600	100+/- 22	100+/- 10	13.2
625	100+/- 22	100+/- 10	12.9
750			11.3
860			10.1

Frequency (MHz)	Min. PSANEXT (dB)	Min. PSAACRF (dB)	Min. TCL (dB)	Min. ELTCTL (dB)
1.000	67.000	67.100	40.000	35.000
4.000	67.000	67.100	40.000	23.000
8.000	67.000	61.100	40.000	16.900
10.000	67.000	59.200	40.000	15.000
16.000	67.000	55.100	38.000	10.900
20.000	67.000	53.200	37.000	9.000
25.000	67.000	51.200	32.000	7.000
31.250	67.000	49.300	35.100	
62.500	66.600	43.300	32.000	
100.000	63.500	39.200	30.300	
200.000	59.000	33.200	27.000	
250.000	57.500	31.200	26.000	
300.000	56.300	29.700	25.200	
350.000	55.300	28.300	24.600	
400.000	54.500	27.200	24.000	
450.000	53.700	26.100	23.500	
500.000	53.000	25.200	23.000	
550.000	52.400	24.400		
600.000	51.800	23.600		
625.000	51.600	23.300		
750.000	50.400	21.700		
860.000	49.500	20.500		

Frequency (MHz)	**Max. Attentuation (dB/100 m)**	**Min. PSNEXT (dB)**	**Min. PSACR (dB)**	**Min. RL (dB)**
1	2.100	73.3	71.2	20.000
4	3.800	64.3	60.5	23.000
8	5.300	59.8	54.4	24.500
10	5.900	58.3	52.4	25.000
16	7.500	55.2	47.8	25.000
20	8.400	53.8	45.4	25.000
25	9.400	52.3	43	24.300
31.25	10.500	50.9	40.4	23.600
62.5	15.000	46.4	31.4	21.500
100	19.100	43.3	24.2	20.100
200	27.600	38.8	11.2	18.000
250	31.100	37.3	6.3	17.300
300	34.300	36.1	1.9	16.800
350	37.200	35.1		16.300
400	40.100	34.3		15.900
450	42.700	33.5		15.500
500	45.300	32.8		15.200
550	47.700	32.2		14.900
600	50.100	31.6		14.700
625	51.200	31.4		14.500
750	56.700	30.2		14.000
860	61.200	29.3		13.600

G. Applications

1. 10GBASE-T Full Power Implementation (IEEE 802.3an).
2. 10GBASE-T Low Power Implementation (Short Reach Mode) (IEEE 802.3an).
3. 1000BASE-T Applications (IEEE 802.3ab).
4. Power Over Ethernet Plus - 2 pairs, up to 30 Watts or 4-pairs, up to 60 Watts (IEEE 802.3at).
5. Power Over Ethernet - 2 pairs, up to 12.95 Watts (IEEE 802.3af).
6. Broadband Video (CATV) & High-Speed Internet (DOCSIS) over UTP up to 860 MHz.

7. High Temperature performance up to 50°C without length de-rating for 1000BASE-T and 100BASE-TX.

H. Design Make: Belden 10GXS13

2.4 CATEGORY 6A MODULAR JACKS

A. ETL - Verified Category 6A

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6A cable

C. Physical Characteristics:

1. Color as determined by owner and matching attached cable color. Provide different colors for each of the following:
   a) Wireless Access Points
   b) Desktop Data and VoIP
   c) Security
   d) Wall mounted VoIP
2. Front Connection Flexible PCB with 50u inch Gold over Nickel.
3. Rear Connection IDC Phosphor Bronze with Tin Plating over Nickel.
4. Connector Body N/A Plastic - UL940V-0

D. Mechanical Characteristics:

1. Footprint/Type: KeyConnect
2. Plug / Jack Compatibility: RJ45,
3. Cable/Connector Retention: 15 lbs.

E. Standards Compliance:

1. FCC Part 68, Subpart F
2. IEC 60603-7
3. ISO/IEC 11801:2002 Amendment 2
4. ACA, Bi-national Standard Listed

F. Electrical Characteristics:

Frequency (MHz)	**Max. Insertion Loss TIA* (dB)**	**Max. Insertion Loss Belden****	**Min. NEXT TIA* (dB)**	**Min. NEXT Belden****	**Min. FEXT TIA* (dB)**	**Min. FEXT Belden**

		(dB)		(dB)		** (dB)
1.000	0.100	0.050	75.000	77.000	75.000	80.000
4.000	0.100	0.050	75.000	77.000	71.100	75.100
8.000	0.100	0.050	75.000	77.000	65.000	69.000
10.000	0.100	0.050	74.000	77.000	63.100	67.100
16.000	0.100	0.060	69.900	72.900	59.000	63.000
20.000	0.100	0.070	68.000	71.000	57.100	61.100
25.000	0.100	0.080	66.000	69.000	55.100	59.100
31.250	0.110	0.090	64.100	67.100	53.200	57.200
62.500	0.160	0.140	58.100	61.100	47.200	51.200
100.000	0.200	0.180	54.000	57.000	43.100	47.100
200.000	0.280	0.260	48.000	51.000	37.100	41.100
250.000	0.320	0.300	46.000	49.000	35.100	39.100
300.000	0.350	0.330	42.900	46.700	33.600	37.600
400.000	0.400	0.380	37.900	42.900	31.100	35.100
500.000	0.450	0.430	34.000	40.000	29.100	33.100
625.000		0.480		37.100		31.200
Mated Connection Table - Footnote: *TIA/EIA-568-B.2-10-2008 Category 6A Standard.						
****Worst-case performance for a 10GX mated connection using 10GX modular plugs.**						

Frequency (MHz)	Max. Return Loss TIA* (dB)	Max. Return Loss Belden** (dB)	Min. PSANEXT TIA* (dB)	Min. PSANEXT Belden** (dB)	Min. PSAACRF TIA* (dB)	Min. PSAACRF Belden** (dB)	Min. Balanced TCL TIA* (dB)	Min. Balanced TCL Belden** (dB)
1.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
4.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
8.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
10.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
16.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
20.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
25.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
31.250	30.000	34.100	70.500	72.000	67.000	72.000	38.100	45.000
62.500	30.000	34.100	70.500	72.000	67.000	72.000	32.100	39.100
100.000	28.000	30.000	70.500	72.000	67.000	72.000	28.000	35.000
200.000	22.000	24.000	64.500	66.000	61.000	66.000	22.000	29.000
250.000	20.000	22.000	62.500	64.000	59.000	64.000	20.000	27.000
300.000	18.500	20.500	61.000	62.500	57.500	62.500	18.500	25.500
400.000	16.000	18.000	58.500	60.000	55.000	60.000	16.000	23.000

500.000	14.000	16.000	56.500	58.000	53.000	58.000	14.000	21.000
625.000		13.000		56.100		56.100		19.100
Dielectric Strength: 1,000 V RMS @ 60 Hz for 1 minute								
Current Rating: 1.500 A								
Insulation Resistance: 50 M-Ohm Minimum								
Max. Contact Rsitance: 20 m-Ohm								
Termination Resistance: 2.5 m -OHM								

G. Design Make: Belden 10GX Modular Jack, Category 6A, RJ45, Key Connect style.

2.5 CATEGORY 6A UTP PATCH PANELS

A. Characteristics:

1. Steel housing
2. 24 or 48 ports as required by the installation
3. Shall be Blank modular panels to accept snap in RJ-45 COLOR CODED jacks as specified in this specification, color to match the attached data cable.
4. Plug / Jack Compatibility - RJ45
5. Refer to modular jack specification for transmission Characteristics.

B. Standards:

1. FCC Part 68, Subpart F, IEC 60603-7
2. ISO/IEC 11801:2002 Amendment 2

C. Design Make: Belden 10GX Patch Panel - KeyConnect

D. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.6 FACE PLATES

A. Provide angled entry faceplates low profile and strain relief.

B. Configured to fit standard single gang outlet box.

C. Accepts all IC107 modules.

D. Rugged and durable ABS plastic construction.

E. UL listed.

F. Acceptable Manufacturers:

1. ICC
2. Belden

3. Panduit

2.7 CABLE IDENTIFICATION:

A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.

B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.

C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.

D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.

E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable.

F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

PART 3 - INSTALLATION

3.1 GENERAL

A. Firestop conduit openings after the cable installation is complete.

B. Separation from Electromagnetic Interference

Condition	Minimum Separation Distance
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal pathway.	152 mm (6 in)

Electrical motors and transformers.	1194 mm (47 in)

C. Installing cables above suspended ceilings

1. Pull or place cables into the zone pathway.
2. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within the zone.
3. Where zone pathways are not provided, divide the floor area into direct-run telecommunications zones.
4. Run all the cables to the center point of their zones.
5. From the center point of each zone, distribute the cables to work areas within that zone.
6. At the center point of each telecommunications zone, support all cables with a cable tie or similar device. Tightly cinched cable ties may have a detrimental effect on transmission performance and should be avoided.
7. Coil in a figure eight any cable that is not in service back to the end of the zone pathway. When required, cable-tie these coiled cables.
8. Label the cables and pathways for easy recognition and establish a working database for ongoing identification and maintenance of horizontal cables and pathways.
9. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

D. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill for the particular raceway type.

E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.

F. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

3.2 UTP CABLE

A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

B. All wiring concealed in new walls or soffits shall be installed in metal conduits.

C. Wiring in existing walls with hollow cavities may be installed loose.

D. All exposed wiring shall be installed in surface metal raceway.

E. All wiring above ceilings shall be installed in cable tray or open top cable hangers and brackets.

F. Cable hangers above accessible ceilings shall be installed 4' on center attached to building structure. If cables have more than 12" of sag, install more hangers.

G. Do not untwist cable pairs more than 0.5 in. when terminating.

H. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.

I. Maximum length shall be 90 meters. (295 ft).

J. Maximum patch cable shall be 5 meters (16 ft).

K. Provide 10 ft service loop in the communications equipment room. Provide 3 foot service loop in ceiling above outlet. Slack should not be stored in bundled loops. Cable loops have had a degrading effect on cabling performance. Cable slack should be stored in an extended loop or in a figure-eight configuration to alleviate stress.

L. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

M. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90o sweeps at all vertical drops.

N. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.

O. Install category 6 cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.

P. Do not install UTP cable with more than 110N (25 lbs) pull force, as specified in EIA/TIA and BICSII TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on: long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use of tensile rated cords (i.e. fishing line) should be used for difficult or questionable pulls - to judge to

go/no-go condition of the conduit and pulling setup.

Q. Care must be taken so that the cable does not bend at any location to a radius less than ten times the diameter of the cable. A cable feeder guide of suitable dimensions should be used between the cable reel and the face of the duct to protect the cable and guide it into the duct as it is payed off the reel.

R. As the cable is payed off the reel, it should be carefully watched and inspected for sheath defects. If defects are noticed, the pulling operation should be stopped immediately and the Engineer promptly notified of the defect. Kinks and/or other irregularities in the cable sheath should be removed or corrected as directed by the engineer.

S. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.

T. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

U. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

V. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.

W. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.

X. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. In hollow-wall installations where box-eliminators are used, excess wire can be stored in the wall. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

Y. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

Z. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

3.3 UTP MODULAR JACKS

A. All cables shall be terminated with modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways or power pole.

B. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.

C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The length of untwisted in a pair at the point of termination to the jack shall be no greater than 0.5 inches (13mm).

D. Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.

E. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.

F. All extra openings to be filled with blank inserts.

G. Terminate cable per EIA/TIA T-568B standard pin assignments.

H. Remove only as much cable jacket as is required for termination and trimming. Follow the manufacturer's instructions for mounting, termination, and cable management. Minimize the amount of untwisting in a pair when terminating to connecting hardware. For untwisting cabling, maintain pair twists as close as possible to the termination point. The length of untwisting must not exceed 12.7 mm (0.5 in) for category 5e and higher cables.

3.4 COMPLETION AND ACCEPTANCE

A. In all spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be performed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer

recommendations.

B. Submit copies of the following:

1. Cable Test Reports (at substantial completion).

3.5 PATCH PANELS.

A. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches (13 mm).

B. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket or other appropriate mounting device.

C. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts.

D. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts. Panels shall be properly labeled on front and back with the cable number and port connections for each port, as per cable schedule drawings.

E. All cables shall be neatly "dressed out" in equipment rooms. Cables to be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.

G. Install factory supplied patch panel labels, in the corresponding T568B configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.

H. The cable jacket shall be maintained as close as possible to the termination point.

3.6 COLOR CODING

A. Prior to submitting cable and connector cuts for approval confirm with the owners IT director the required cable and jack colors.

3.7 CEILING TILES

A. The cabling contractor shall replace all ceiling tiles that are damaged due to cable installation. Tiles shall match the existing.

B. Prior to beginning work walk the proposed cable routes and document any existing damage with the construction manager.

3.8 ATTACHMENT CABLES:

A. Attachment cable assemblies, for use between workstation and room data connector, attenuation requirements ANSI/TIA/ EIA-568A, ISO9001, ISO/IEC 11081. Cables shall be Category 6, 24 AWG stranded conductors, #RJ45 connectors at each end.

B. Contractor shall furnish (1) attachment cable for each room data drop, cable length shall be as noted below unless noted otherwise on Drawings.

Area	Length
Classroom (Standard Rm.)	8'-0"
Computer Classroom	8'-0"
Library	8'-0"
Office/Administrative Areas	7'-0"

Note: Provide any additional attachment cables with strain relief boots for completion. Refer to Technology Room Layouts on Contract Drawings for quantity and length required.

3.9 CABLE IDENTIFICATION:

A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self-adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.

B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.

C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.

D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.

E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable.

F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

END OF SECTION 271513

SECTION 282305 – MODIFICATIONS TO EXISTING VIDEO SURVEILLANCE SYSTEM

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. Section includes modifications made to the existing Elementary School video surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.

B. Related Requirements:
   1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables". or.
   2. Section 271500 "Horizontal Cabling CAT 6 and 6A.

C. The owner will furnish IP CCTV cameras.

D. Provide category 6 cable from the closest IDF closet to each camera.

E. Provide surge arrestor for all exterior cameras.

F. Mount and aim all cameras as directed by the owner’s security contractor.

1.3 DESCRIPTION OF EXISTING VIDEO SURVEILLANCE SYSTEM

A. The existing system consists of Cisco Systems, Inc. - Meraki security cameras.

1.4 MODIFICATIONS TO EXISTING VIDEO SURVEILLANCE SYSTEM

A. Provide installation of Owner furnished video surveillance system cameras as indicated on the Drawings.

1.5 DEFINITIONS

A. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.6 SEQUENCING AND SCHEDULING

A. Existing Video Surveillance Equipment: Maintain existing equipment fully operational until system modifications have been tested and accepted.

B. Equipment Removal: After acceptance of new system, remove existing disconnected equipment and associated wiring.

1.7 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings:

1. Include plans, elevations, sections, and details, including details of attachments to other Work.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
3. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
4. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
5. Wiring Diagrams: For power, signal, and control wiring.

6. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.8 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Qualification Statements: For Installer.

1.9 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace video surveillance system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: 3 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXISTING VIDEO SURVEILLANCE SYSTEM TO BE MODIFIED

A. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections as recommended by manufacturer for type of line being protected.

C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NECA 1.

D. Comply with NFPA 70.

E. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.3 POWER SUPPLIES

A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera.

1. Enclosure: NEMA 250, Type 1.

2.4 CAMERA-SUPPORTING EQUIPMENT

A. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.

B. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

1. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
2. Duplex Receptacle: Internally mounted.
3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
4. Built-in, thermostat-activated heater units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
5. Sun shield shall not interfere with normal airflow around the housing.
6. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
7. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
8. Enclosure Rating: NEMA Type 4X, IP67 protection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Prior to modifying the system, perform tests to ascertain the operating condition of the existing system. Test shall be witnessed by the Company Field Advisor. Prepare a written report for the Director’s Representative indicating the repairs required, if any, to make the existing sub-systems function properly.

C. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

E. Review fixed camera viewing angle and field of view with Owner and adjust as required by Owner prior to installation of camera.

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Interruption of Existing Video Surveillance System Service: Do not interrupt service to facilities occupied by Owner unless permitted under the following conditions:

1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Construction Manager's written permission.

C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Install cameras and infrared illuminators level and plumb.

C. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect/adjust all controls and alarms.

E. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

F. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1 enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor

G. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.

H. Avoid ground loops by making ground connections only at the control station.

1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.

I. Connecting to Existing Equipment: Verify that existing video surveillance system is operational before making changes or connections.
1. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to new points. New components must be capable of merging with existing configuration without degrading performance of either system.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

E. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inch (2440 mm) above floor must be installed in EMT.

B. Pathways must be installed in EMT.

3.6 GROUNDING

A. Provide independent-signal circuit grounding recommended in writing by manufacturer.

B. Ground equipment and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Ground shielded cables at control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction.

B. Administrant for Tests and Inspections:
1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

C. Tests and Inspections:

1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
   a. Verify operation of auto-iris lenses.

b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
d. Set and name all preset positions; consult Owner's personnel.
e. Set sensitivity of motion detection.
f. Connect and verify responses to alarms.
g. Verify operation of control-station equipment.

3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

D. Video surveillance system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.1 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.2 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

END OF SECTION 282305

SECTION 284621 – MODIFICATIONS TO EXISTING FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The specified modifications will replace existing fire alarm systems within all areas of renovation and expand the existing fire alarm system as necessary to serve all areas of new construction in the Elementary School. Modifications made to the existing Elementary School fire alarm system:
   1. Manual fire-alarm boxes.
   2. System smoke detectors.
   3. Duct smoke detectors.
   4. Carbon monoxide detectors.
   5. Heat detectors.
   6. Fire-alarm notification appliances.
   7. Fire-alarm addressable interface devices.
   8. Engineering and reprogramming associated with the installation of the new equipment and updating existing information.

B. Related Requirements:

   1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
   2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables"
   3. Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.3 DESCRIPTION OF EXISTING FIRE ALARM SYSTEM

A. The existing Fire-Lite Alarms by Honeywell Model MS-9200UDLS Fire Alarm Control Panel (FACP) operates as the head-end for an integrated multiplexed protected premises and proprietary fire alarm, monitoring and control system. Changes in the status of monitored points are detected by the micro-processor based proprietary supervising station and protected premises subsidiary stations located throughout the building.

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. NICET: National Institute for Certification in Engineering Technologies.

C. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.5 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until system modifications have been tested and accepted. When 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 building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and associated wiring.

1.6 ACTION SUBMITTALS

A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.

B. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

C. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.

2. Include plans, elevations, sections, and details, including details of attachments to other Work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Include voltage drop calculations for notification-appliance circuits.
5. Include battery-size calculations.
6. Include input/output matrix.
7. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.

1.7 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Qualification Statements: For Installer.

C. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
d. Device addresses.
e. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.

2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

f. Manufacturer's required maintenance related to system warranty requirements.

1.9 QUALITY ASSURANCE

A. UL Listing: The system products for the modifications shall be listed in the UL Fire Protection Equipment Directory under product category “Control Units System (UOJZ)”.

B. Company Field Advisor: Company Field Advisor shall be National Institute for Certification in Engineering Technologies (NICET) certified as Level III or higher Fire Alarm Protection/Fire Alarm Systems Engineering Technician. Secure the services of a Company Field Advisor from the Company of the existing system for a minimum of 24 working hours at the contract site for the following:
1. Render advice and witness test of existing system.
2. Render advice regarding modifications to the system.
3. Assist in reprogramming the system.
4. Witness final system test and then certify with an affidavit that the modifications were installed in accordance with the contract documents and are operating properly.

C. Installer Qualifications:

1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
2. Installation must be by personnel certified by NICET technician.
3. Obtain certification by NRTL in accordance with NFPA 72.
4. Licensed or certified by authorities having jurisdiction.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 EXISTING FIRE-ALARM SYSTEM TO BE MODIFIED

A. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system. Provide all necessary system components and associated wiring connections to accommodate all system work indicated on the drawings.

2.2 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
2. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
3. Station Reset: Key- or wrench-operated switch.
4. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm. Lifting cover actuates integral battery-powered audible horn intended to discourage false-alarm operation.
5. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm.
6. Able to perform at up to 90 percent relative humidity at 90 deg F (32 deg C).
7. Material: Manual stations made of Lexan polycarbonate.
8. Able to be used in indoor or outdoor areas.

2.3 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:
1. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 268.

b. General Characteristics:

1) Detectors must be four or two-wire type.
2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:

a) Primary status.
b) Device type.
c) Present average value.
d) Present sensitivity selected.
e) Sensor range (normal, dirty, etc.).

8) Detector must have functional humidity range within 90 percent relative humidity.
9) Color: White.
10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, alarm condition and individually adjustable for sensitivity by FACU.
11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 20 deg F (11 deg C) per minute.
12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 deg F (57 deg C).
13) Multiple levels of detection sensitivity for each sensor.
14) Sensitivity levels based on time of day.

2.4 DUCT SMOKE DETECTORS

A. Description: Photoelectric-type, duct-mounted smoke detector.

B. Performance Criteria:

1. Regulatory Requirements:

    a. NFPA 72.
    b. UL 268A.

2. General Characteristics:

    a. Detectors must be four-wire type.
    b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
    c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
    d. Integral Visual-Indicating Light: LED type, indicating detector has operated with power-on status.
    e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
    f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:

        1) Primary status.
        2) Device type.
        3) Present average value.
        4) Present sensitivity selected.
        5) Sensor range (normal, dirty, etc.).

    g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
    h. Each sensor must have multiple levels of detection sensitivity.
    i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
    j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.5 CARBON MONOXIDE DETECTORS

A. Description: Carbon monoxide detector listed for connection to fire-alarm system.

B. Performance Criteria:

1. Regulatory Requirements:

    a. NFPA 72
    b. NFPA 720.
    c. UL 2075.

2. General Characteristics:

a. Mounting: Adapter plate for outlet box mounting.
b. Testable by introducing test carbon monoxide into sensing cell.
c. Detector must provide alarm contacts and trouble contacts.
d. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
e. Locate, mount, and wire in accordance with manufacturer's written instructions.
f. Provide means for addressable connection to fire-alarm system.
g. Test button simulates alarm condition.

2.6 HEAT DETECTORS

A. Combination-Type Heat Detectors:
1. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 521.

b. General Characteristics:

1) Temperature sensors must test for and communicate sensitivity range of device.

c. Actuated by fixed temperature of 135 deg F (57 deg C) or rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
f. Detector must have functional humidity range of 90 percent relative humidity.
g. Color: White.

B. Fixed-Temperature-Type Heat Detectors:
1. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 521.

b. General Characteristics:

1) Actuated by temperature that exceeds fixed temperature of 190 deg F (88 deg C).
2) Mounting: Twist-lock base interchangeable with smoke-detector bases.
3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
4) Detector must have functional humidity range of 90 percent.
5) Color: White.

2.7 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Audible Notification Appliances:
1. Description: Horns or other notification devices that cannot output voice messages.
2. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.

b. General Characteristics:

1) Individually addressed, connected to signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
2) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

B. Fire-Alarm Voice/Tone Notification Appliances:
1. Description: Notification appliances capable of outputting voice evacuation messages.
2. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 1480.

b. General Characteristics:

1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

2) High-Range Units: Rated 2 to 15 W.
3) Low-Range Units: Rated 1 to 2 W.
4) Mounting: Surface mounted and bidirectional.
5) Matching Transformers: Tap range matched to acoustical environment of speaker location.
6) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Fire-Alarm Visible Notification Appliances:
1. Performance Criteria:

a. Regulatory Requirements:

1) NFPA 72.
2) UL 1971.

b. General Characteristics:

1) Rated Light Output:
a) 15/30/75/110 cd, selectable in field.

2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
3) Mounting: Wall mounted unless otherwise indicated.
4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
5) Flashing must be in temporal pattern, synchronized with other units.
6) Strobe Leads: Factory connected to screw terminals.
7) Mounting Faceplate: Factory finished, Red.

2.8 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:

a. NFPA 72.

2. General Characteristics:

a. Include address-setting means on module.
b. Store internal identifying code for control panel use to identify module type.
c. Listed for controlling HVAC fan motor controllers.

d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
e. Integral Relay: Capable of providing direct signal to circuit-breaker shunt trip for power shutdown.

1) Allow control panel to switch relay contacts on command.
2) Have minimum of two normally open and two normally closed contacts available for field wiring.

f. Control Module:

1) Operate notification devices.
2) Operate solenoids for use in sprinkler service.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.

B. Prior to modifying the system, perform tests to ascertain the operating condition of the existing system. Tests shall be witnessed by the Company Field Advisor. Prepare a written report for the District indicating any repairs necessary to make the existing sub-systems function properly and insure full capability of supporting the work indicated on the drawings.

C. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 PREPARATION

A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:

1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before other trades have completed cleanup must be replaced.
2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that the existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of building.
2. Connect new equipment to existing monitoring equipment at supervising station.
3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to new points. New components must be capable of merging with existing configuration without degrading the performance of either system.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in normal path of egress within 60 inch (1520 mm) of exit doorway.
2. Mount manual fire-alarm box on background of contrasting color.
3. Operable part of manual fire-alarm box must be between 42 and 48 inch (1060 and 1220 mm) above floor level. Devices must be mounted at same height unless otherwise indicated.

D. Smoke- and Heat-Detector Spacing:

1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing must not exceed 30 ft. (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
5. HVAC: Locate detectors no closer than 36 inch (910 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inch (300 mm) from lighting fixture and not directly above pendant mounted or indirect lighting.

E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.

F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inch (9100 mm) long must be supported at both ends.

1. Do not install the detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

G. Audible Alarm-Indicating Devices: Install not less than 6 inch (150 mm) below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.

H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch (150 mm) below ceiling. Install devices at same height unless otherwise indicated.

I. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inch (2440 mm) above floor must be installed in EMT.

B. Pathways must be installed in EMT. Exceptions: Pathways installed exposed at Outdoor locations, sump and ejector pits, elevator pits, loading docks, garages, rooftops, gymnasiums and Boiler/Mechanical Rooms/Main Electrical Rooms must be installed in GRC: Galvanized rigid steel conduit.

C. Exposed conduit must be painted red enamel.

3.7 CONNECTIONS

A. Make addressable connections with supervised interface device. Install interface device less than 36 inch (910 mm) from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.

B. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in location visible from FACP.

3.9 GROUNDING

A. Ground FACP and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction.

B. Administrant for Tests and Inspections:
1. Perform tests and inspections with assistance of factory-authorized service representative.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
    b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.

2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.

4. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
5. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
6. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.

E. The fire alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

END OF SECTION 284621

SECTION 311000 - SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes

1. Protection of trees, shrubs and other vegetation
2. Clearing and grubbing of site
3. Implementation of soil erosion and sediment control procedures
4. Demolition and removal of existing site features
5. Disposal of waste materials

1.02 DESCRIPTION

A. Design Requirements

1. The contractor shall clear and grub the site as required to perform the construction shown on the contract documents. Clearing and grubbing of the site shall be confined closely to the limits shown on the contract documents.
2. Site preparation operations required, but not limited to in the work, include:
   a. Protection of existing trees, shrubs and vegetation.
   b. Removal of existing trees, shrubs and vegetation as indicated on the contract documents.
   c. Clearing and grubbing.
   d. Transplanting and relocating of existing trees and shrubs as indicated on the contract documents.
   e. Temporary fencing.
   f. Topsoil stripping.
   g. Removal of above grade improvements and subsurface infrastructure.
   h. Disconnecting and removing all existing utilities except those designated to remain.
   i. Removal of debris.
   j. Dust control.

1.03 SEQUENCING AND SCHEDULING

A. Coordinate site preparation operations with the following:

1. Work with other prime contractors.
2. Shut down and relocation of site utilities in field of operations.
3. Various stages of completion in the project schedule.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine conditions under which site preparation work is to be accomplished in coordination with the installer components specified in this Section. Notify affected Prime Contractors, the Owner's Representative and the Architect in writing of any conditions detrimental to proper and timely accomplishment of the required work. Do not proceed with site preparation work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

1. When the installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to the Architect written confirmation from the applicable installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

B. Perform the following prior to starting site preparation work:

1. Inspect the entire project site including all objects that are designated to remain or to be removed.
2. Locate all underground infrastructure and utilities and determine requirement for their protection.
3. Preserve in operating condition all active utilities traversing the site and designated to remain.
4. Schedule site preparation work in consideration of adjacent public and private property owners.
5. Avoid interference with use of and passage to and from adjacent buildings and facilities.

3.02 PREPARATION

A. Protect existing objects designated to remain, both on and off the project site. In the event of damage, immediately make all repairs and replacements necessary for approval of the Owner's Representative and the Architect.

B. Prevent spread of dust during performance of the work throughout the life of the project. Thoroughly moisten all site areas as required to prevent dust from being a nuisance to the Owner, public, neighbors and performance of other work on the site.

C. Use all means necessary to minimize interference with roads, streets, walks, and other traveled areas. Do not close, obstruct, or cause to make impassable any traveled areas without first obtaining permission from the appropriate agencies.

D. Remove, relocate, store and protect from damage items designated to be savaged.

3.03 PROTECTION OF EXISTING TREES, SHRUBS AND VEGETATION

A. Install temporary fencing as required to protect existing trees, shrubs and other vegetation which are scheduled to remain from above ground damage including smothering of root systems. Do not store construction materials, debris or excavated materials within the drip line of trees. Restrict vehicular traffic, parking and pedestrian traffic from tree drip line areas to prevent excessive compaction of soil over root systems.

B. Trees, shrubs or vegetation scheduled to be saved that are damaged during construction work due to contractor negligence shall be placed under the care of a certified nurseryman or arborist. The Prime Contractor responsible for the damage to the plant material shall be liable for the cost of all required work. Trees, shrubs or vegetation that die as a result of contractor negligence shall be evaluated by a qualified nursery industry professional selected by the Owner's Representative. The removal and replacement of the affected trees, shrubs or vegetation and the associated evaluation expenses shall be the responsibility of the contractor.

3.04 CLEARING AND GRUBBING

A. Remove trees, shrubs and other vegetation that interfere with the installation of new construction or grading work, except for those indicated to remain. Use only hand methods for grubbing inside the drip line of trees indicated to remain. Removal of plant material includes the excavation and off-site disposal of new and old stumps of trees, shrubs and other vegetation and their entire root mass.

B. Depressions caused by clearing operations shall be filled with satisfactory soil material unless further excavation or earthwork is required.

3.05 IMPLEMENTATION OF SOIL EROSION AND SEDIMENT CONTROL PROCEDURES

A. Install temporary and permanent measures to mitigate soil erosion and sediment control issues as directed by the Architect or interested State Agencies. Work may include the installation of berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, sloped drains and other erosion control devices.

B. The temporary soil erosion and sediment control measures indicated on the Contract Documents shall be coordinated with the specified permanent erosion control features to the extent practical to assure economical, effective and continuous erosion control.

3.06 DEMOLITION AND REMOVAL OF EXISTING SITE FEATURES

A. Remove foundations, pavement, sidewalks, curbs, retaining walls and other site features noted for removal that are encountered as part of the work.

1. Remove asphalt concrete paving material to full depth and remove from site.
2. Gravel and stone fill under removed sidewalks may be reused if suitable for the particular new use and approved by the Project Designer.
3. Remove below grade structures such as retaining walls to a minimum depth of 2'-0" below new finished grade unless specifically noted otherwise within the Contract Documents.
4. Break up and completely remove miscellaneous concrete such as small foundations.

B. Leave cut edge neat and square where existing material is cut to adjoin new work.

3.07 DISPOSAL OF WASTE MATERIALS

A. Burning on the Owner's property of combustible cleared and grubbed material is not permitted.

B. Remove all combustible cleared and grubbed material, excess excavated subgrade material, broken stone, broken concrete, masonry materials, and debris from the Owner's property and legally dispose of it. Obtain all permits for off-site disposal and submit a copy of each permit to the Owner's Representative.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Clearing and grubbing.
B. Removal of topsoil.
C. Underground utilities.
D. Excavation.
E. Rock excavation and blasting.
F. Dewatering.
G. Settlement detection.
H. Placing engineering fabric.
I. Placing fill and backfill.
J. Placing fill to support structures.
K. Compaction.
L. Rough grading.
M. Subgrade surface for walks and pavement.
N. Finish grading.
O. Maintenance and restoration.
P. Disposal of excess and unsuitable materials.
Q. Field quality control.
R. Protection.

1.02 RELATED SECTIONS

A. Section 023000 – Subsurface Investigations
B. Section 024113 – Selective Site Demolition
C. Section 311000 – Site Preparation
D. Section 312317 – Site Trenching
E. Section 312500 – Erosion and Sediment Control
F. Section 321216 – Asphalt Paving
G. Section 321313 – Concrete Paving
H. Section 321613 – Concrete Curbs
I. Section 329200 – Turf and Grasses
J. Section 333000 – Sanitary Sewer System

1.03 DEFINITIONS

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

1. Excavation - The removal of all surface and subsurface material not classified as rock (as defined below).
2. Rock - Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.5 cubic yards.

    a. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation. Concrete building foundations and concrete slabs, where indicated, shall be classified as earth excavation. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

3. Unclassified Earth Excavation - The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this Contract. These materials shall include:

    a. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.
    b. Ledge rock of all quality including limestone, sandstone, shale, granite and similar materials in solid beds or masses in its original or stratified position which can only be removed by drilling, wedging, use of pneumatic tools or heavy ripping equipment. Blasting operations will not be permitted to loosen any ledge rock necessary to be removed in this Contract without prior written permission from the Architect and the Owner's Representative.
    c. Boulders of any size.
    d. Any materials of man-made origin.

4. Subgrade Surface - Surface upon which gravel base or topsoil is placed.
5. Base - Select granular material or Type 1 or Type 2 base course which is placed immediately beneath pavement or concrete slabs.
6. Fill - Placement of specified fill materials, in layers, above ground surface to required elevations.
7. Backfill - Placement of specified backfill material, in layers, in excavations to required subgrade elevations.
8. Foundation Bearing Grade – Grade or elevation at which bottom of footings is to be constructed.
9. Maximum Density - The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).

10. Structures - Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
11. Landscaped Areas - Areas not covered by structures, walks or paving.
12. Unauthorized Excavation - The removal of material below required elevations indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.

1.04 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures.

B. Product Data - Submit manufacturer's name, specifications and installation instructions as applicable for each item specified.

C. Samples - At the Owner's discretion, take samples in the presence of the Owner's Representative, and submit to the Owner's Independent Testing Laboratory for analysis. Test for gradation, proctors and soundness shall be completed with results submitted to the Owner's Designated Representatives. Tests shall be performed in accordance with ASTM standards, shall be performed and signed by a certified soils laboratory, and shall be submitted as part of the original submittal. At a minimum, unless agreed to differently, the samples taken shall be of the following quantities:

1. Select Type 1 Granular Material - 40 to 50 lbs.
2. Type 2 Base Course - 40 to 50 lbs.
3. Drainage Fill – 40 to 50 lbs, mixed to specification.

D. Quality Control Submittals – Provide documentation complying with the following:

1. Base Materials - Name and location of source with the D.O.T. Source Number. If the material is not being taken from an approved D.O.T. source, the results of the gradation and soundness tests performed by an ASTM certified soils laboratory will be required.
2. Other Aggregates - Name and location of source and soil laboratory test results.
3. Excavation Procedure - Submit a lay out drawing or detailed outline of intended excavation procedure for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.
4. Soil Erosion and Sediment Control - Submit plan complying with the requirements of Section 312500.

E. Closeout Procedures - Comply with the requirements of Section 017700.

1.05 QUALITY ASSURANCE

A. General - The systems listed reflect the intent to establish required earthwork function and standard of quality for construction.

1.06 PROJECT CONDITIONS

A. Field Measurements - Establish and maintain required lines and elevations for grade control.

B. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

C. Cold Weather Requirements – Comply with the following:

1. Excavation - When freezing temperatures are anticipated, do not excavate to final design elevations for concrete work unless concrete can be placed immediately.
2. Backfilling - If backfill is being placed during freezing temperatures, the backfilling operations shall be monitored by the Owner's Representative and the following procedures shall be followed:

    a. Frozen ground shall be removed in its entirety from beneath and five (5) feet beyond the area of fill placement.
    b. Fill material placed shall consist of Select Fill and shall be free of all frozen chunks that exceed four (4) inches in size. Material transported to the project site shall only consist of material excavated from below frost depth.
    c. At the end of the work-day, the area of fill placement shall be covered with insulated blankets, or left protected. Other means of protection (hay, wood chips etc.) may also be used provided it is approved by the Owner's Representative.
    d. Following work-day - Remove insulated blankets or other approved protection methods and strip the area of all frozen material as specified previously.

e. Upon establishing subgrade elevations, protect grades with insulated blankets or place additional material that will adequately insulate the exposed earth surface from frost. This additional fill or protective material shall be stripped just prior to pouring concrete.

D. Subsurface Information/Site Investigation Reports - Site investigation reports including soil boring logs and similar data included in the Construction Documents are intended to represent only conditions found at locations indicated at the time investigations were conducted. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or of continuity of such conditions. The Owner will not be responsible for interpretation or conclusions drawn there from by the Contractor.

1. The Contractor may perform additional test borings and other exploratory operations at no additional cost to the Owner upon approval of the Owner's Representative.

E. Land Survey Information - Field verify provided existing boundary and topographic information prior to beginning site work. Immediately report any discrepancies in boundary locations or topographic elevations affecting site construction to the Owner's Representative. Provide profile information on existing site conditions and verification of existing topographic information to the Owner's Representative prior to beginning site construction. Beginning site work construction without this profile information and written notification indicates the Contractor's acceptance of the existing land survey data indicated on the Drawings as accurate. Adjustments to the Contract will not be made for discrepancies brought to the Owner's attention after site construction has begun.

1.07 SEQUENCING AND SCHEDULING

A. Proceed with, and complete earth moving operations as rapidly as portions of the work area become available, working within seasonal limitations for the tasks required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Select Type 1 Granular Material: Where indicated, supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
3-inch	76.2	100
2-inch	50.8	90-100
1/4 inch	6.35	30-65
No. 40	0.425	5-40
No. 200	0.075	0-10

B. Base Course Type 2 Crushed Stone: Where indicated, supply stockpiled, crushed ledge rock or approved blast furnace slag. Comply with New York State Department of transportation gradation and material requirements modified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
2-inch	50.8	100
1/4 inch	6.35	25-60
No. 40	0.425	5-40
No. 200	0.075	0-10

C. Drainage Fill: Equal blend of No.1 and No. 2 washed crushed or uncrushed stone.

a. No. 1 Coarse Aggregate:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.4	100
½ inch	12.7	90-100
¼ inch	6.35	0-15

b. No. 2 Coarse Aggregate:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	38.1	100
1 inch	25.4	90-100
½ inch	12.7	0-15

D. Engineering Fabric: Fabric composed of high tenacity polypropylene yarns woven into a stable network. The fabric is to be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum. Average Roll Value
Wide Width Tensile Strength	ASTM D 4595	kN/m m^2	MD 17.6 (100)/CD 21.0 (120)
Grab Tensile Strength	ASTM D 4632	kN (lbs)	MD 0.9 (200)/ CD 0.9 (200)
Grab Tensile Elongation	ASTM D 4632	%	MD 15/CD 10
Trapezoid Tear Strength	ASTM D 4533	kN (lbs)	MD 0.33 (75)/CD 0.33 (75)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2756 (400)
Puncture Strength	ASTM D 4833	kN (lbs)	0.4 (90)
Percent Open Area	COE-02215-86	%	1
Apparent Opening Size (AOS)	ASTM D 4751	mm (US Sieve)	0.300 (50)
Permittivity	ASTM D 4491	sec^{-1}	0.05
Flow Rate	ASTM D 4491	l/min/m^2 (gal/min/ft^2)	200 (5.0)
UV Resistance (at 500 Hours)	ASTM D 4355	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m^2 (oz/ydm^2)	136 (4.0)
Thickness	ASTM D 5199	mm (mils)	0.51 (20)
Roll Dimensions (Width X Length)	-----	m (ft)	3.8 X 132 or 5.3 X 94.2 (12.5 X 432) or (17.5 X 309)
Roll Area	-----	m2 (yd2)	502 (600)
Estimated Roll Weight	-----	kg (lb)	95 (210)

1. Manufacturer: For convenience, details have been based on Mirafi 500X as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

E. Structural Fill: Imported material consisting of clean sand, gravel, crushed gravel, or a mixture of these, and shall contain no organic matter. Imported structural fill materials shall meet the NYSDOT Standard Specifications gradation for Select Granular Fill (Item No. 733.1101).

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions - Examine conditions under which earthwork is to be accomplished with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Protection

1. Use of explosives: Do not bring explosives onto the site or use on the project without prior written permission from the Architect and the Owner's Representative. The Contractor remains solely responsible for the handling, storage and use of explosive materials when permitted. Use explosives in strict compliance with State, Local and OSHA regulations.
2. Protection of Persons and Property:

    a. Barricade open excavations and post with warning lights for safety of persons. Operate warning lights during hours from dusk to dawn each day.
    b. Protect structures, utilities, sidewalks, pavements and other facilities immediately adjacent to excavations from damage caused by settlement, lateral movement, undermining, washout and other hazards.
    c. Take precautions and provide necessary bracing and shoring to guard against movement and settlement of existing improvements or new construction. Contractor remains entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

3.03 CLEARING AND GRUBBING

A. Clear and grub the site within the grading limit lines of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.

1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching

B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.

3.04 REMOVAL OF TOPSOIL

A. Remove existing topsoil from areas within the grading limit lines where excavation or fill is required.

B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.

1. Topsoil shall be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.05 UNDERGROUND UTILITIES

A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.

B. Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.

C. Utilities to remain in service shall be re-routed as shown on the Contract Drawings.

D. Utilities abandoned beneath and five (5) feet laterally beyond a structure's proposed footprint shall be removed in their entirety. Excavations required for their removal shall be backfilled and compacted as specified herein.

E. Unless otherwise noted in the Contract Documents, utilities extending outside the limit specified above (5 feet) may be abandoned in place provided their ends are adequately plugged as described below.

1. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.

2. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for type of material and size of pipe. Do not use wood plugs.
3. Close open ends of concrete and masonry utilities with concrete or flow-able fill.

F. Coordinate with other Prime Contractors or with local utility companies, as applicable, for shutoff service if lines are active.

G. Coordinate scheduling of removal to accommodate relocation of lines when necessary.

H. Demolish and remove or relocate additional uncharted underground utilities conflicting with construction operations as directed by the Architect. Measure additional removal and relocations as directed by the Architect and paid for by the Owner as a Change Order.

3.06 EXCAVATION

A. Excavate earth as required for the work. Remove and dispose of all materials encountered to obtain required subgrade elevations. Remove from property and legally dispose of all excess fill material.

B. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified in Section 312500, on the Contract Drawings or as directed by local officials.

C. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).

1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

D. Stockpile excavated materials classified as suitable material where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage as approved by the Owner's Representative.

E. Excavation for Structures - Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1". Extend excavation a sufficient lateral distance to provide clearance to execute the work.

F. Footings and Foundations - The foundation bearing grade shall be established just prior to constructing concrete foundations when concrete is to bear on undisturbed soil.

1. Stepping Footings - Cut sloping surfaces under footings, foundations, steps, and where required for other work as indicated.
2. Pile Foundations - Stop excavations 6 to 12 inches above the bottom of pile cap elevation before the piles are placed. After pile installation, remove loose and displaced material and excavate to final grade, leaving a solid base to receive concrete pile caps.
3. Where footings and other work requiring similar soil support will rest entirely on rock, remove loose soil and loose rock and place concrete to the required elevations. Where footings and other work requiring similar soil support will rest partially on rock and partially on soil, immediately notify the Owner's Representative before any backfilling or concrete placement occurs; the Owner's Representative will determine the correct foundation treatment for the work.

G. Slabs and Floors - Excavate to the following depths below bottom of concrete for addition of select granular material:

1. Interior Floors – 6" unless otherwise indicated.
2. Exterior Slabs and Steps – 12" unless otherwise indicated.

H. Pipe Trenches - Refer to Section 312317.

I. Open Ditches - Cut ditches to cross sections and grades indicated.

J. Pavement - Excavate to subgrade surface elevation.

K. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular Type 1 material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Owner's Representative.

1. Unauthorized excavations under structural work such as footings, foundation bases, and retaining walls shall be reported immediately to the Owner's Representative before any concrete or backfilling work commences.

L. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved.

M. Removal of Unsuitable Material Beneath Structures and Other Improvements - Excavate encountered unsuitable materials which extend below required elevations to additional depth as directed by the Owner's Representative. Have cross sections taken, under the supervision of an independent Land Surveyor, to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.

N. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor and exceeding the numeric quantities indicated on the Drawings, will be paid for at a pre-negotiated or pre-established unit price by Change Order.

3.07 ROCK EXCAVATION AND BLASTING

A. Excavation - Consists of the removal and disposal of materials encountered that cannot be excavated with a 1½ cubic yard capacity power shovel without drilling and blasting or requiring use of specialized equipment.

1. Typical Rock Classified Materials: Boulders 1½ cubic yards or more in volume, solid rock, rock in ledges, and rock hard cementitious aggregate deposits.

a. The Contractor shall classify intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered as earth excavation.

2. Rock payment lines shall be limited to the following:

a. Two feet outside of concrete work for which forms are required, except footings.
b. One foot outside of perimeter footings.
c. In pipe trenches, six inches below invert elevations of pipes and two feet wider than the inside diameter of the pipe, but not less than three foot minimum trench width.
d. Neat outside dimensions of concrete work where no forms are required.
e. Under slabs on grade, six inches below bottom of concrete slab.

B. Blasting - Perform blasting operations using skilled personnel, in compliance with governing regulations. Comply with ANSI A10.1 "Safety Code for Building Construction".

1. Store explosives, if permitted on the Owner's property, only where directed by the Owner's Representative and in proper storage structures. Keep storage facilities securely locked at all times for inspection and for delivery

and storage of explosives. Provide full time watchman and other controls as required by governing regulations.

2. Conduct blasting operations using explosives of such quantity and power, and fired in such sequence and locations, to avoid injury to personnel or damage to property or adjacent construction. Assume full responsibility for damages resulting from or attributable to blasting operations.

3.08 DEWATERING

A. Refer to subsurface logs included in the Contract Documents for information regarding subsurface conditions. The Owner shall not be liable for Change Orders resulting from the Contractor's inability to properly dewater the site.

B. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.

C. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

D. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

E. Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

F. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.09 SETTLEMENT DETECTION

A. Excavating Beneath the Bearing Grades of an Existing Structure - Establish a settlement detection method approved by the Owner's Representative for structures subject to settlement from excavation, sheeting or sheet piling operations. Maintain surveillance to detect any settlement.

B. Surcharging - Establish a settlement monitoring plan to accurately determine the settlements that have occurred and the rate that they occurred to adequately determine when settlement caused by surcharge is complete.

3.10 PLACING ENGINEERING FABRIC

A. Place and overlap engineering fabric in accordance with the Manufacturer's installation instructions, unless otherwise shown.

B. Cover tears and other damaged areas with additional engineering fabric layer extending 3 feet beyond the damage.

C. Do not permit traffic or construction equipment directly on engineering fabric.

D. Backfill immediately over engineering fabric. Backfill in accordance with the fabric manufacturer's instructions and in a manner to prevent damage to the fabric.

3.11 PLACING FILL AND BACKFILL

A. Surface Preparation of Fill Areas - Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Refer to Section 311000 – Site Preparation for additional information.

1. Remove all asphalt pavement in its entirety from areas requiring the placement of fill.
2. After topsoil is stripped and other improvements specifically indicated to be removed on the Contract Documents are removed, proof roll the site with a ten-ton vibratory compactor (minimum six overlapping passes required) or similar equipment. Excavate soft or loose soils identified during rolling and replace with properly compacted select Type 1 granular material as directed by the Owner's Representative or the Project Designer. Measure additional excavation and backfill as directed by the Owner's Representative or the Project Designer for payment by the Owner as a Change Order.
3. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill materials bond with the existing surface.

B. Excavations - Backfill as promptly as work permits, but not until completion of the following:

1. Acceptance by the Owner's Representative of construction below finish grade including, where applicable, dampproofing, waterproofing, perimeter insulation, and bearing capacity of supporting soil.
2. Inspection, testing, approval and recording locations of underground utilities.

3. Removal of concrete formwork.
4. Removal of temporary sheeting (or sheet piling) and backfilling of voids caused by removals.
5. Cutting off top of permanent sheeting (or sheet piling).
6. Removal of trash and debris.
7. Installation of permanent or temporary bracing on horizontally supported walls.

C. Place backfill and fill materials in layers not more than 8" thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.

1. Place fill and backfill against foundation walls and in confined areas (such as trenches) not easily accessible by larger compaction equipment, in maximum 6" thick (loose depth) layers.
2. For large fill areas, the layer thickness may be modified by the Owner's Representative, at the Contractor's written request, if in the Owner's Representative's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request shall include the type and specifications of compaction equipment intended for use.

D. Prevent wedging action of backfill against structures by placing backfill uniformly around the structure to approximately the same elevation in each layer. Place backfill against walls of structures containing basements or crawl spaces only after the first floor structural members are in place.

E. Foundation Drains: Refer to Section 334000.

F. Perimeter Insulation: Before insulation is installed, place and tamp specified backfill to a smooth plane even with the required elevation of the lower surface of the insulation.

G. Under exterior concrete slabs and steps, utilize the following fill materials:

1. Type 1 granular material from subgrade to within 6" of the concrete slab or steps.
2. Select Type 2 crushed stone for the next 6".

H. Under interior concrete slabs, utilize the following fill materials:

1. Select Type 1 granular material from subgrade to within 6" of the building slab.
2. Select Type 2 granular material for the next 6".

3. Provide vapor barrier above select Type 2 granular material as indicated on the drawings.

I. Against dampproofed or waterproofed structure faces or structure faces with foundation drains, utilize select Type 1 granular material.

J. Under Pavements and Walks - Utilize select Type 2 crushed stone as indicated on the Construction Drawings and in the applicable specification sections in the Project Manual.

K. Landscaped Areas: Place suitable material, when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over 4" in diameter within the top 12" of suitable material.

3.12 ADDITIONAL REQUIREMENTS FOR PLACING FILL TO SUPPORT STRUCTURES

A. Place fill at the perimeter of the structure to be constructed as follows:

1. Strip the area in accordance with the requirements for "Surface Preparation of Fill Areas" included in this Specification Section.
2. Compact the stripped surface to 95% of maximum density.
3. Place fill in horizontal layers not exceeding 8" loose depth and compact layers as specified.

B. Place fill within the perimeter of the structure to be constructed as follows:

1. Strip the area in accordance with the requirements for "Surface Preparation of Fill Areas" included in this Specification Section.
2. Proof roll the stripped surface with at least 5 passes of a vibratory drum compactor having a minimum unsprung drum weight of 7 tons unless specifically indicated otherwise in the Contract Documents. Notify the Owner's Representative of the proposed date for beginning proof rolling at least 2 working days prior to commencing proof rolling.
3. Excavate unsuitable materials (soft and unstable earth) disclosed by the proof rolling operation and replace with compacted Select Type 1 granular material.
4. Place fill in horizontal layers not exceeding 8" in loose depth and compact layers as specified.

C. Obtain written approval of fill area compaction before excavating for footings.

D. Excavate for footing width plus 1 foot on each side.

E. Excavate 1 foot below footing elevations where bottom of footings are 2 feet or less above or 4 feet or less below original ground surface.

1. Compact footing bottom and place a 1-foot bed of select granular material. Compact select granular material in 6″ layers.
2. Omit excavation and select granular material below bottom of footings where footing elevations are more than 2 feet above or more than 4 feet below the original ground surface.

3.13 COMPACTION

A. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than 3% drier nor more than 2% wetter than the optimum content as determined by ASTM D 1557 (Modified Proctor).

1. Structures (entire area within 10 feet outside perimeter) - Compact subgrade and each layer of backfill or fill material to 95%.
2. Concrete Slabs and Steps - Compact subgrade and each layer of backfill or fill material to 95%.
3. Landscaped Areas - Compact the top 2′-0″ to a maximum of 85% and compact all subgrade areas beneath the upper 2′-0″ to 95%.
4. Pavements and Walks - Compact subgrade and each layer of backfill or fill material to 95%.
5. Pipes and Tunnels - Compact subgrade and each layer of backfill or fill material to 95%.
6. Pipe Bedding - Compact subgrade and each layer of backfill or fill material to 95%.

B. Compaction Equipment:

1. Provide compaction equipment of suitable size and number and in satisfactory working condition to complete construction on schedule.
2. Use sheepsfoot rollers, pneumatic tired rollers, vibrating tampers, or other compaction equipment capable of obtaining required density throughout the entire layer being compacted.

C. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.

D. Moisture Control:

1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
2. Remove and replace or scarify and air dry soil that is too wet to permit compaction to the specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.

E. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. If compaction cannot be achieved, the material/layer shall be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

3.14 ROUGH GRADING

A. Interior Grading - Trim unexcavated spaces within the building to levels indicated.

1. Subgrade for Interior Slabs: Compact as specified to receive fill material. Finish subgrade surface within 1″ above or below level specified for fill required.

B. Exterior Grading - Trim and grade area within the grading limits of the Contract Documents and excavations outside the limits, required by this Contract, to a level of 6″ below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide a smooth uniform transition to adjacent areas.

1. Grade areas outside building lines for each structure to drain away from structures and to prevent ponding of water. Finish surfaces free from irregular surface changes and large stones.
2. Landscaped Areas: Provide uniform subgrade surface within 1″ of required level to receive topsoil thickness specified. Compact fill as specified to within 2″ of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top 4″ of the subgrade has become compacted above 85% before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of 4″ immediately prior to placing topsoil.

3.15 SUBGRADE SURFACE FOR WALKS AND PAVEMENT

A. Shape and grade subgrade surface as follows:

1. Walks - Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than a ½" above or below the required subgrade surface elevation.
2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½" above or below the required subgrade surface elevation.

B. Grade Control - During construction, maintain lines and grades, including crown and cross-slope of subbase course.

C. Thoroughly compact subgrade surface for walks and pavement by mechanical rolling and tamping, or with vibratory equipment as approved to the density specified.

D. Shoulders - Place shoulders along edges of filled subgrades to prevent lateral movement. Construct shoulders of specified fill material, placed in such quantity to compact to thickness of each subgrade course layer.

3.16 FINISH GRADING

A. Uniformly grade rough graded areas within the grading limits to finish grade elevations indicated.

B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.

C. Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.

D. Finish surfaces free from irregular surface changes, and as follows:

1. Grassed Areas - Finish areas to receive topsoil to within 1" above or below the required subgrade surface elevations.
2. Walks - Place and compact base material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface not more than a ½" above or below the required subbase elevation.
3. Pavements - Place and compact base material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½" above or below the required subbase elevation.

4. Building Slabs - Grade base material smooth and even, free of voids, compacted as specified, and to required subbase elevation. Finish final grades within a tolerance of a ¼" when tested with a 10 foot straightedge.
5. Surfaces To Receive Vapor Barrier - Provide smooth surfaces graded, tamped and/or rolled, entirely free of obstructions or protruding objects.

E. Spread topsoil directly upon prepared subgrade surface to a depth measuring a minimum of 6" after natural settlement of the topsoil has occurred in areas to be seeded or to receive sod unless specifically indicated otherwise within the Contract Documents. Place to greater depth when necessary to adjust grades to required elevations.

1. Only approved existing topsoil within the grading limits may be used. Provide additional topsoil from outside sources as required.

F. Finish topsoil surface free of depressions which will trap water, free of stones over ½" in any dimension, and free of debris.

3.17 MAINTENANCE AND RESTORATION

A. Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

C. Topsoil and seed or sod damaged lawn areas inside and outside the indicated grading limits. Water as required until lawn areas are accepted by the Owner's Representative.

3.18 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from the work site and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

B. If acceptable to the Owner's Representative, transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on the Project Site designated by the Owner's Representative, and dispose of such materials as directed.

C. Transport excess topsoil to areas on the Project Site designated by the Owner's Representative. Smooth grade deposited topsoil.

3.19 FIELD QUALITY CONTROL

A. Tests - The Owner may provide soil testing and inspection services during earthwork operations. The Owner reserves the right to test and approve all subgrades and fill layers before construction proceeds. Refer to Section 014500 – Quality Control for additional requirements relating to testing.

B. Compaction Testing: Provide the Owner's Representative adequate notice for all phases of filling and backfilling operations. Compaction testing will be performed by the Owner's Testing Agency to ascertain the compacted density of the fill and backfill materials. Compaction testing will be performed on certain layers of the fill and backfill as determined by the Owner's Representative and the Testing Agency. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. No additional material may be placed over a compacted layer until the specified density is achieved.

C. Tests of subgrades and fill layers may, at the Owner's option, include:

1. Observation of proof rolling procedures.
2. Observation and or inspection of unsuitable soil material.
3. Footing subgrades, for each strata of soil for which footings will be placed, at least one plate bearing test and field density test may be conducted if the subgrade is non-cohesive, or unconfined compression test may be conducted if the subgrade is cohesive, to verify design bearing capacities shown on the Drawings. Subsequent verification and approval of each footing subgrade may be based on visual comparison of each subgrade with tested strata when acceptable to the Architect.
4. Paved areas and building subgrade areas, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made. In addition, in each compacted fill layer, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made.
5. Foundation wall backfill, field density tests at locations and elevations as directed may be made, with at least one test made for every 50 feet of wall.
6. Fill under footings, in each compacted fill layer; one compaction test for every 30 LF of wall may be taken. One compaction test may be made under each individual footing.

D. If in the opinion of the Architect and based on reports of the testing service, completed subgrades or fills are below the specified density, provide additional compaction and testing at no additional expense to the Owner.

3.20 PROTECTION

A. Protect graded areas from traffic and erosion and keep them free of trash and debris.

B. Repair and re-establish grades and seeding in settled and rutted areas to specified tolerances.

END OF SECTION 312000

SECTION 31 23 01 - EXCAVATION, BACKFILL, AND COMPACTION (BUILDING AREA)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.

1.2 DESCRIPTION OF WORK

A. This section pertains to an area bounded by 20-feet-minimum outside of and parallel to the exterior walls of the building, including canopies, loading docks, and other structures attached to the building.

B. This work includes the following:

1. Preparing subgrade for building slabs, walks, and pavements.
2. Preparing subbase for support of building slabs.
3. Excavating and backfilling for building structure.
4. Excavating and backfilling of trenches within building lines.
5. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
6. Excavating and backfilling for Mechanical/Electrical Work. Refer to mechanical and electrical sections for excavation and backfill required in conjunction with underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
7. Final grading and placement and preparation for topsoil for lawns and planting are specified in Division 310000 – Site Earthwork.

1.3 QUALITY ASSURANCE

A. Comply with: New York State Department of Transportation (NYSDOT) "Standard Specifications for Construction and Materials."

B. Routine testing of existing soils and compacted material for compliance with these specifications will be performed as part of Special Inspections. See Section 014533.

1. Compacted material not meeting density requirements shall be removed or recompacted and retested at Contractor's expense.

1.5 MATERIAL EVALUATION/QUALITY CONTROL

A. Preconstruction Testing: Owner shall employ a special inspection program to perform the following services. See Section 014533.

B. Geotechnical Engineer shall submit copies of reports to Special Inspector, Engineer, Architect, Construction Manager, and Contractor. Include date of site visit, description of work observed, and summary of observations and recommendations.

1.6 SUBMITTALS

A. Submit to RDP for Geotechnical Engineering:

1. Product data, specifications, and installation instructions for proprietary materials.
2. Material certifications for products specified to conform with NYSDOT references and ASTM references.

B. Prior to placement of slab on grade, submit to Special Inspector and RDP for Structural Engineering a written protection program for vapor retarder, slab subbase, and slab on grade for record only.

1.7 DEFINITIONS

A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

B. Unauthorized Excavation: Removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect. Unauthorized excavation and remedial work directed by Architect shall be at Contractor's expense.

1. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position when acceptable to Architect.
2. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification unless otherwise directed by Architect.

C. Additional Excavation: If RDP for Geotechnical Engineering determines bearing materials at required subgrade elevations are unsuitable, continue excavation until

suitable bearing materials are encountered. Replace excavated material as directed by Geotechnical Engineer.

1. Removal of unsuitable material and replacement as directed will be paid on basis of conditions of contract relative to changes in work.

D. Subgrade: Undisturbed earth or compacted soil layer immediately below granular subbase, base of structure, or topsoil materials.

1.8 PROJECT CONDITIONS

A. Site Information: Subsurface investigation reports were used for basis of design and are available to Contractor for information only. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.

1. Additional test borings and other exploratory operations may be performed by Contractor at Contractor's option; however, no change in contract sum will be authorized for additional exploration.

B. Existing Utilities: Locate existing underground utilities in work area before starting earthwork operations. Where utilities are to remain in place, provide adequate means of protection during earthwork operations.

1. If uncharted or incorrectly charted piping or other utilities are encountered during excavation, consult with utility owner and Architect immediately for directions. Cooperate with Owner and public and private utility companies to keep services and facilities in operation. Repair damaged utilities as required by utility owner.
2. Do not interrupt existing utilities serving facilities occupied by Owner or others during occupied hours except when permitted in writing by Architect and then only after acceptable temporary utility services have been provided.
   a. Provide minimum 48-hours notice to Architect and receive written notice to proceed before interrupting utilities.
3. Demolish and remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

C. Use of Explosives: Do not bring explosives onto site or use in work.

D. Protection of Property: Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1. Perform excavation by hand within drip line of large trees to remain. Protect root systems from damage and from drying out to greatest extent possible. Maintain moist condition for root system, and cover exposed roots with moistened burlap.

1.9 PRODUCT HANDLING

A. Store materials so as to preserve their quality and fitness for work.

1.10 WORKMANSHIP

A. Contractor shall be responsible for correction of work not conforming to specified requirements. Correct deficient work as directed by Architect.

B. Remove work found to be defective. Replace with new acceptable work.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General Fill Material: Soil materials free of clay, rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

B. Structural Fill: NYSDOT Select Granular Fill (Item No. 733.1101) Sound and durable sand and gravel, free of deleterious materials such as pyritic shale, organics, or contaminants of a chemical, mineral, or biological nature and conforming to the following limits of gradation:

Percent Passing by Weight	Sieve Size
100	4 inch
0 – 70	No. 40
0 – 15	No. 200

C. Drainage Fill: Washed crushed stone or crushed or uncrushed gravel conforming to NYSDOT Filter Type 1 (Item No. 733.2001) as specified as follows.

Sieve Size	Percent Finer by Weight
1 inch	100
1/2 inch	30 - 100
1/4 inch	0 - 30
No. 4	0 - 10
No. 8	0 – 5

G. Filter Fabric: "Geotex 351" by Propex Geosynthetics; "Mirafi 140N" by Mirafi, Inc.; or accepted equivalent.

H. Excavated Materials: Do not use as structural fill or subbase material. Do not use as general fill material unless accepted by Geotechnical Engineer.

I. Foundation Drainage Pipe: Perforated Polyvinyl Chloride (PVC) Pipe conforming to ASTM D 3034, SDR 35, size as noted on the Drawings. Provide bends, reducers, adapters, couplings, collars, and joint materials as required.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

A. Examine substrates and conditions under which work shall be performed. Do not proceed with work until unsatisfactory conditions are corrected.

B. Maintain drainage and restrict traffic within building area during construction to maintain integrity of subgrade. Failure to observe these precautions will require Contractor to remove disturbed areas and correct at his expense.

3.2 COLD-WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.3 REMOVALS

A. Clear, grub, and strip site of vegetation, topsoil, and other organic materials.

B. Remove brick fragments and other construction debris. Plow-strip or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material can bond with existing surface.

1. When existing ground surface has a density less than that specified for a particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

C. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash, and debris. Legally dispose off Owner's property.

3.4 PROOF ROLLING

A. Following stripping and removing miscellaneous fill, grade and compact exposed subgrade. Proof roll subgrade by making five passes across building area in each direction using smooth-drum vibrating roller having static weight of 10 tons minimum.

B. Undercut soft spots that develop during proof rolling and replace with compacted structural fill. Contractor shall be paid for this work on unit cost basis.

D. Do not perform proof rolling during or immediately after periods of inclement weather.

3.5 EXCAVATION

A. Excavation shall be considered unclassified and understood to mean all materials encountered during excavation.

B. Excavations shall be laid back or sheeted and braced to prevent sloughing in of sides. Maintain sides and slopes of excavations in stable condition until completion of backfill. Incline cut slopes no steeper than permitted by OSHA standards for excavations in soil type(s) encountered.

C. Hand trim foundation excavations to remove loose soil or ridges of materials left by equipment.

D. Keep loose material and debris out of excavations.

E. Shoring and Bracing: Provide materials for shoring and bracing, including sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.

1. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops minimum 2 feet 6 inches below final grade, and leave permanently in place.

3.6 DEWATERING

A. Dewatering activities shall conform to Stormwater Pollution Prevention Plan (SWPPP) implemented by site operator if required as a condition of construction permit.

B. Perform excavation and filling in manner and sequence to provide proper drainage at all times.

C. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting of footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.7 STORAGE OF EXCAVATED MATERIALS

A. On-site storage of excavated materials shall conform to Stormwater Pollution Prevention Plan (SWPPP) implemented by site operator if required as condition of construction permit.

B. Stockpile excavated materials acceptable for reuse. Place, grade, and shape

stockpiles for proper drainage.

1. Locate and retain soil materials away from edges of excavations. Do not store within drip lines of trees indicated to remain.
2. Dispose of excess excavated soil material and materials not acceptable for use as general fill.

3.8 TRENCH EXCAVATION FOR PIPES AND CONDUIT

A. Excavate trenches to uniform width sufficiently wide to provide ample working room and minimum of 6 to 9 inches of clearance on both sides of pipe or conduit.

B. Do not locate trenches that are deeper than adjacent footings closer horizontally to footing than vertical distance separating bottom of trench and bottom of footing.

C. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

1. For pipes or conduit less than 6 inches in nominal size and for flat-bottomed, multiple-duct conduit units, do not excavate beyond indicated depths. Hand-excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
2. For pipes and equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom of pipe for 90 degrees (bottom 1/4 of the circumference). Fill depressions with bedding or tamped cushion sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads to ensure continuous bearing of pipe barrel on bearing surface.

3.10 FILLING, BACKFILLING, AND COMPACTION

A. Do not place fill material on surfaces that are muddy, frozen, or contain frost or ice.

B. Use structural fill to increase grades within building areas, as interior backfill against foundations and in trenches, as exterior backfill against walls with footing drains and as exterior backfill where pavement or walkways abut building.

C. Use subbase material directly below slabs and pavements as shown in drawings.

D. Use general fill material to increase grades outside building area except as otherwise specified.

E. Use drainage fill around footing drains. Wrap drainage fill with filter fabric.

F. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and are carried below bottom of such footings or pass under wall footings. Place concrete to level of bottom of adjacent footing.

G. Backfill foundation excavations as soon as possible following construction of foundations and foundation walls.

H. Backfill and fill against foundation walls evenly on both sides to prevent displacement of construction. For walls with fill on one side only, do not backfill until concrete has achieved 70 percent of its design strength and walls have been braced.

I. Begin filling in lowest section of area.

J. Place fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

K. Lifts or portions thereof not compacted in accordance with specifications shall be recompacted or removed and replaced to meet compaction requirements.

L. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density in accordance with ASTM D 1557, Modified Proctor:

1. Under structures, footings, foundations, building slabs, and steps: Compact top 12 inches of subgrade and each layer of fill material to 95 percent.
2. Under pavements: Compact top 12 inches of subgrade and each layer of fill material to 95 percent.
3. Subbase Material: Compact to 95 percent with moisture content no greater than 2 percent wet of optimum.
4. Under walkways: Compact top 6 inches of subgrade and each layer of fill material to 95 percent.
5. Under lawn or unpaved areas: Compact top 6 inches of subgrade and each layer of fill material to 90 percent.
6. Cushion sand: Compact to 100 percent.

M. Where a power roller is used for compaction, do not approach nearer than 10 feet from walls of new or existing construction.

N. Moisture Control: Where subgrade or layer of soil material must be moisture-conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material. Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

1. Remove and replace or scarify and air dry soil material too wet to permit compaction to specified density.
2. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to satisfactory value.

3.11 TOLERANCES

A. Excavation for structures shall conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot except to facilitate drainage during construction stage.

B. Surface of subbase under building slabs shall be graded smooth and even, free of voids, and rolled to required elevation. Provide final grades within tolerance of 1/2 inch when tested with 10-foot straightedge.

3.12 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspection program to perform field tests and inspections and prepare test reports. See Section 014533

END OF SECTION

SECTION 312317 - SITE TRENCHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Trench excavation, backfill and compaction of underground piping and underdrainage.

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving
B. Section 333000 – Sanitary Sewer System

1.03 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Backfill Product Data: Submit test reports for each type of gravel and/or stone specified for backfill naming the source of each material. Submit evidence that each backfill material complies with Department of Transportation standard specifications for the materials specified.

C. Quality Control Submittals

1. Experience Listing: Submit a list of completed projects similar to this project, including owner's contact information and telephone number for each project.

D. Closeout Procedures: Comply with the requirements of Section 017700.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

1.05 PROJECT CONDITIONS

A. Field Measurements: Establish and maintain required lines and elevations for grade control.

1.06 SEQUENCING AND SCHEDULING

A. Proceed with and complete trenching operations as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Excavated Material: Utilize on-site excavated materials consisting of loam, clay, sand, gravel or other material suitable for backfilling as approved by the Project Designer when the type of backfill material is not indicated on the Contract Documents.

B. Sand: Natural bank sand complying with the following gradation requirements:

1. 100% passing the ¾" sieve
2. Less than 5% passing the Number 200 sieve.

C. Select Type 1 Granular Material: Where indicated supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
3 inch	76.2	100
2 inch	50.8	90-100
1/4 inch	6.35	30-65
No. 40	0.425	5-40
No. 200	0.075	0-10

D. Bedding Material: Mixture of 50% No. 1 and 50% No. 2 stone complying with the following New York State Department of Transportation Standard Specifications:

No. 1 Stone Gradation Requirements

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.4	100
1/2 inch	12.70	90-100
1/4 inch	6.35	0-15
No. 200	0.075	0-1

No. 2 Stone Gradation Requirements

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 ½ inch	38.1	100
1 inch	25.4	90-100
1/2 inch	12.7	30-65
No. 200	0.075	0-10

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which trenching operations are to occur with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 EXCAVATION

A. Excavate trenches to line and depth as indicated on the Contract Documents. Provide consistent, uniform support for the bottom quadrant of each section of piping, fittings and associated materials.

1. Excavate no more than length of trench that can receive infrastructure installation and backfill.
2. Brace and drain trenches as required. Accumulations of groundwater or storm runoff shall be immediately discharged by dewatering pumps to siltation basins or protected channels, drains or storms sewers.
3. Provide adequate trench width to permit successful laying and joining of pipe, proper placement of backfill and clearance of at least 8" on either side of the pipe barrel.
4. Prepare the finish grade of the trench bottom with hand tools. Where elevations are not shown on the Contract Documents, excavate the trench to place a minimum of 18" of fill above the top of the pipe. Provide "bell holes" at each pipe joint for proper joining to eliminate point bearing. Stones of 2"

or greater in any dimension or as recommended by the pipe manufacturer, whichever is smaller, shall be removed to avoid point bearing.

5. Where trench excavation is carried below the specified elevation as a result of Contractor error or negligence, backfill the trench with Select Type 1 Granular Material and compact to required densities at no cost to the Owner.
6. When trenching is required within the dripline of trees, tunnel under or around roots by hand digging. Do not cut tap roots or main lateral roots.

B. Rock Excavation: Comply with the requirements outline in Project Manual Section 312000- Earth Moving.

C. Excavated Materials

1. Materials satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench sufficient to avoid overloading and to prevent slides and cave-ins.
2. Adequate drainage shall be provided for the stockpiles and surrounding areas by means of ditches, dikes and other approved methods.
3. Stockpiles shall be protected from contamination with unsatisfactory excavated material or other material that destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles and any material becomes unsatisfactory as a result, such material shall be removed and replaced with satisfactory on site or imported materials from approved sources at no additional cost to the Owner.
4. Excavated material not required or not satisfactory for backfill shall be removed from the site.

3.03 BACKFILLING

A. Trench Backfill: Trenches shall be backfilled to grade upon completion of required testing work.

B. Bedding and Initial Backfill: Bedding shall be of the type and thickness as indicated on the Contract Documents or as recommended by the pipe manufacturer.

1. Initial backfill material shall be placed in layers of a maximum of 6" loose thickness and compacted with approved tampers to the density of the adjacent in-situ soil, and to a height of at least one foot above the utility pipe, conduit or other infrastructure item. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe.
2. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe.

C. Final Backfill: The remainder of the trench shall be backfilled with satisfactory material removed from the trench. Backfill material shall be deposited and compacted as follows:

1. Under building slabs, roads, walks, parking lots and other structural areas, backfill shall be deposited in maximum 8" loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.
2. Under general landscape areas, backfill shall be deposited in maximum 12" loose thickness layers and compacted to 95% maximum dry density at +/-2% of optimum moisture content.

3.04 FIELD QUALITY CONTROL

A. Testing

1. The Owner may provide soil testing and inspection services during the backfill of trenches as outlined in Project Manual Section 014500 – Quality Control.
2. Prime Contractors shall employ the services of an independent testing agent to observe and test backfill operations performed by other Prime Contractors that may affect their work. An independent testing laboratory shall certify that the backfill is suitable for finish construction to be installed over trenches.
3. Prime Contractors shall submit copies of testing laboratory reports to the Owner's Representative and the Architect for information only.
4. The General Work and Site Work Prime Contractors shall accept in writing any trench backfill and compaction by other prime contractors before installing the remaining finish construction over trench work.

END OF SECTION 312317

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SECTION 312500 - EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 Applicable provisions of the Contract Documents govern work under this section.

1.2 WORK INCLUDED

A. Provide all labor, equipment and materials necessary to maintain erosion control blankets, silt fence, hay bale dikes, sediment traps, inlet protection, and to implement erosion control measures as shown on plans, as required by regulatory permits, and as job conditions dictate.

B. Related Work Specified Elsewhere:

1. Section 311000 – Site Preparation
2. Section 312000 – Earth Moving
3. Section 329200 – Turf and Grasses

1.3 QUALITY ASSURANCE: All Erosion/Sediment Control activities and water quality objectives performed by the Contractor shall be in compliance with the following standards of practice:

A. NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity.

B. NYSDEC's "New York Standards and Specifications for Erosion and Sediment Control" as published by the Empire State Chapter of the Soil and Water Conservation Society.

C. NYSDEC's "New York State Stormwater Management Design Manual" as prepared by the Center for Watershed Protection.

D. USDA Soil Conservation Service's "Guidelines for Urban Erosion and Sediment Control", latest revision.

E. NYSDEC's "Erosion and Sediment Control Guidelines for New Development T.O.G.S. 5-1.10".

F. Local Guidelines for Erosion and Sediment Control.

G. NYSDEC's "Reducing the Impacts of Stormwater Runoff for New Developments", latest revision.

H. NYSDOT Specifications.

I. Directives of the Owner, Architect and/or regulatory personnel of authority having jurisdiction requiring further control measures as warranted.

1.5 SEQUENCING AND SCHEDULING

A. Place erosion control measures wherever shown on the Contract Drawings before beginning any other Work of this Contract.

B. Place other erosion control measures shown on the Contract Drawings as soon as possible, relative to other Work of this Contract including, but not limited to, the following:

1. At grading limits, before beginning rough grading.
2. In drainage channels, as soon as subgrade is established.
3. In drainage channels, as soon as topsoil and seed are applied.
4. At drainage structures, as soon as backfill is compacted and frame and grate are installed.
5. At flared end sections, as soon as installation is complete.
6. At all disturbed ground and subgrade as specified.

PART 2 - PRODUCTS

2.1 MULCHES: Mulches shall be suitable material acceptable to the Project Designer and reasonably clean and free of noxious weeds and deleterious materials. The following materials are acceptable:

		Application Rates		
Mulch Material	Quality Standards	Per 1000 SF	Per Acre	Depth
Wood chips or shavings	Green or air-dried, free of objectionable coarse material.	500-900 lbs.	10-20 tons	2 - 7"
Straw	Air-dried; free of undesirable seeds and coarse materials	90-100 lbs. 2-3 bales	2 tons 100-120 bales	Cover about 90% of the surface

2.2 GRASS

A. Grass shall be quick growing species suitable to the area and as a temporary cover which will not compete with the grasses sown later for permanent cover.

B. Seed Mixtures

1. Temporary Seeding

Type	Lbs./Acre	Lbs./1000SF
a. Ryegrass (Annual or Perennial)	80	1.9
b. Certified Aroostook Winter Rye	100	2.5

Use winter rye if seeding in October/November.

2.3 SOIL AMENDMENTS

A. Fertilizer and soil conditioners shall be a standard commercial grade acceptable to the Architect.

1. Lime: pH of 6.
2. Fertilizer: Meeting New York State Department of Transportation Specification 713-03 Type 1 or as approved. 1-2-1 N.P.P. ratio.

2.4 EROSION CONTROL BLANKET: Provide rolled erosion control product, biodegradable erosion control blanket, designed for use on slopes as per NYSDOT Approved Material List for rolled erosion control products and soil stabilizers, Class 1, Type C (short term).

2.5 SILT FENCE

A. Silt Fence: Assembled from filter fabric stapled to 36 inch long, 2 inch square hardwood posts or pre-asembled product of equivalent performance characteristics as detailed on the Contract Drawings and in compliance with Storm Water Pollution Prevention Plan.

1. Filter fabric: Shall be on the NYSDOT Approved Material List for geotextiles, approved for use with silt fence, unsupported with 1.2m spacing.

2.6 STABILIZED CONSTRUCTION ENTRANCE: 50/50 mixture of NYSDOT Standard Specifications for Item No. 3 and No. 4 stone.

2.7 CHEMICAL BINDER: Non-toxic conforming to Item 713-12 of NYSDOT Specifications.

2.8 RIP-RAP: Per NYSDOT Specifications.

2.9 STONE: Sound durable stone per NYSDOT Specification Section 703, size(s) per plans.

2.10ADDITIONAL PRODUCTS: As specified and illustrated on the project plans, as required by regulatory permits, and as job conditions dictate.

PART 3 - EXECUTION

3.1 Contractor shall implement erosion control measures as shown on the plans, as job conditions dictate. Intent is to minimize erosion and pollutants at the source, capture sediment at regular intervals and prevent sediment intrusion into storm sewer pipes, structures, and waterways. Work includes, but is not limited to hay bales, mulching, temporary silt fences, filter fabric, expeditious grading, stormwater diversion, prompt turf establishment, sediment dikes, and maintenance of same.

3.2 The Contractor shall initiate stabilization measures as soon as practicable in portions of the

site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased. If disturbed soils surfaces are to be left exposed for a period of greater than 14 days, stabilize the soil with temporary seeding and/or mulch to limit erosion. Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceased is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practical. The onset of seasonally adverse weather is not intended as an excuse for not implementing the necessary erosion controls. The Contractor shall use foresight in his activities to only disturb areas that he can stabilize before adverse weather conditions prevail. The Contractor is encouraged to schedule his work such that final land surface restoration closely follows initial disturbance to the maximum extent possible in order to limit bare soil exposure and dependence on the temporary systems discussed above.

3.3 Sediment shall be removed from sediment traps, sediment ponds, or other devices whenever their capacity has been reduced by fifty (50) percent from the design capacity and/or as required to ensure intent. Prior to fine grading and restoration, the Contractor shall remove and dispose of accumulated sediments and silts as required.

3.4 AUTHORITY OF WORK

A. The Owner and Architect has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing the surface area of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses and water bodies.

3.5 POLLUTION CONTROL

A. Provide methods, means and facilities required to prevent contamination of soil, water or atmosphere by the discharge of noxious substances from construction operations. Promptly repair equipment leaks. Provide equipment and personnel to perform emergency measures required to contain any spillages, and to remove contaminated soils or liquids.

B. Notify Owner, Architect and regulatory authorities having jurisdiction if contaminated soil, groundwater or other forms of pollution are encountered. Excavate and dispose of any contaminated earth immediately in accordance with Federal, State and local regulations off-site, and replace with suitable compacted fill.

C. Pollutants such as fuels, lubricants, bitumens, raw sewage and other harmful materials shall not be discharged into or near rivers, streams, and impoundments or into natural or man-made channels leading thereto. Wash water or waste from concrete mixing operations or trucks shall not be allowed to enter live streams.

3.6 DEWATERING AND WASHWATERS

A. Water from aggregate washing, equipment washing, dewatering or other operations containing sediment, shall be treated by filtration, settling basin or other means sufficient to reduce the turbidity, so as not to cause a substantial visible contrast to natural conditions.

3.7 DIVERSION BERMS/SWALES

A. Slopes of significantly barren slopes exceeding 15 percent require special treatment such as water diversion berms, swales, straw bale sediment barriers, sodding, approved mulch tacking agent over straw mulch applied over seeded areas, or a combination thereof.

3.8 SILT FENCE INSTALLATION

A. A silt fence may be used subject to the following conditions:

1. Maximum allowable slope lengths contributing runoff to a silt fence are:

Slope Steepness	Maximum Slope Length (Ft)
2:1	50
3:1	75
4:1	100
5:1	150
Flatter than 5:1	150 or as shown on the plans

2. Maximum drainage area for overland flow to a silt fence shall not exceed 2 acres per 100 feet of fence.
3. Erosion would occur in the form of sheet erosion.
4. There is no concentration of water flowing to the barrier.

B. Woven wire fence to be fastened securely to fence posts with wire ties or staples.

C. Filter cloth to be fastened securely to woven wire fence with ties spaced every 24" at top and mid-section.

D. Embed silt fence material a minimum of 6 inches below finished grade.

E. When two sections of filter cloth adjoin each other, they shall be overlapped by six inches and folded.

F. Maintenance shall be performed as needed and material removed when bulges develop in the silt fence, or when 6 inches of sediment has accumulated against it, whichever occurs first. All sediment barriers shall be repaired or replaced when they no longer function as a barrier.

3.9 CONSTRUCTION OPERATIONS

A. When borrow material is obtained from other than commercially operated sources, erosion of the borrow site shall be so controlled, both during and after completion of the work, so that erosion will be minimized and sediment will not enter streams or other bodies of water. Waste or disposal areas and construction roads shall be located and constructed in a manner that will minimize sediment-entering streams. Install sediment containment devices around stockpiles and waste areas. Stabilize the surface of temporary haul roads to minimize sediment creation.

B. Install stabilized construction entrances at all ingress/egress points to local and state roads as required and as detailed on the plans.

3.10 CONSTRUCTION PHOTOGRAPHS

A. The Contractor shall take good quality photographs of streams, ditches, channels, ponds or other water bodies immediately adjacent to project work area that will receive runoff from construction activity. Document existing conditions such as existing sediment deposition, water turbidity, eroded streambed/streambanks and condition of vegetation.

3.11 CONSTRUCTION SCHEDULE

A. Prior to beginning construction, the Contractor shall submit for review and acceptance, a detailed project schedule which outlines his program for controlling erosion, limiting conveyance of silt and sediment, pollution prevention, maintenance of devices and controls, and restoration of graded surfaces for the duration of the project and the one-year warranty period.

B. The Architect may limit the area of clearing and grubbing, excavation, trenching and embankment operations in progress, commensurate with the Contractor's capability, responsiveness, and progress in keeping the finish grading, mulching, seeding and other such permanent control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

3.12 FINAL STABILIZATION

A. Final stabilization is defined as all soil disturbing activities at the site having been completed, and that a uniform perennial vegetative cover with a density of at least 80% has been established or equivalent stabilization measures (such as the use of mulches or geotextiles) have been employed on all unpaved areas and areas not covered by permanent structures.

3.13 REMOVAL OF TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES

A. Remove erosion control devices when final stabilization has occurred for the respective areas of the site and are no longer needed.

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Aggregate base for asphalt paving
B. Asphalt paving installation over aggregate base
C. Joining new asphalt pavement to adjacent construction
D. Field quality control

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving
B. Section 321313 – Concrete Paving
C. Section 321613 – Concrete Curbs
D. Section 321723 – Pavement Markings

1.03 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.

C. Job Mix Formulas: Submit job mix formulas for asphalt paving indicating compliance with the requirements of each asphalt type specified including the name and location of the supplier.

D. Quality Control Submittals

1. Certificates: Submit one copy of all permits obtained from local regulatory agencies and the New York State Department of Transportation.
2. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements specified below in the "Quality Assurance" section of this specification.
3. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable requirements specified in the "Quality Assurance" section of this specification.

E. Closeout Procedures: Comply with the requirements of Section 017700.

1.04 QUALITY ASSURANCE

A. Asphalt Producer Qualifications: Use only materials furnished by bulk asphalt producer regularly engaged in the production of hot-mix, hot laid asphalt.

B. Regulatory Requirements

1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, which ever is more stringent for methods and materials in work areas subject to applicable agency's review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
2. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

1.05 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply tack coats when ambient temperature is below 50 degrees F., and when the temperature has not been above 35 degrees for 12 hours immediately prior to the application. Do not apply a tack coat when an asphalt base is wet or contains an excess of moisture.
2. Do not construct asphalt surface courses when the atmospheric temperature is below 40 degrees F., and when base material is not dry. Asphalt may only be placed when air temperatures are a minimum of 40 degrees F. and rising.

B. Field Measurements: Establish and maintain required lines and elevations for grade control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base: Comply with the New York State Department of Transportation Standard Specification, Section 304, Paragraph 304-2, as modified in Section 31 20 00 – Earth Moving.

a. Base Course: Type 2 crushed stone as modified in Section 312000 – Earth Moving unless specifically noted otherwise on the Contract Documents.

B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification. Section 400 for the materials indicated.

1. Binder Course: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt – Type 3 Binder.

2. Topcourse: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt – Type 7 Topcourse.

C. Coatings: Comply with the New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.

1. Tack Coat: Emulsified asphalt, slow setting type, New York State Department of Transportation designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).

2.02 EQUIPMENT

A. Paving Equipment: Spreading, self propelled asphalt paving machines capable of maintaining the line, grade and minimum surface thickness specified. Spreader boxes may be used in areas where specifically approved by the Architect.

B. Compacting Equipment: Self-propelled tandem roller with a minimum 10-ton weight. Handheld vibrator compactor may be used in areas not accessible to rollers when specifically approved by the Architect.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

b. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable

warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Final Preparation of Subgrades: Upon completion of preparation of subgrades as specified in Section 312000, thoroughly scarify the entire area to be paved and compact by rolling to smooth, hard, even surface. Finish to required grades with allowance for pavement courses above.

3.03 INSTALLATION

A. Aggregate Base: Comply with the requirements of the New York State Department of Transportation Standard Specification, Section 304-3, for aggregate gradations specified, unless otherwise indicated.

1. Base Course: Completely fill voids with grits and roll with a 10-ton roller, eliminating movement of the material ahead of the roller. After rolling, verify grading with a minimum ten-footlong straight edge. Satisfactorily eliminate any depression over ¼" deep. Obtain approval of base prior to installing asphalt courses above.

B. Asphalt Paving: Pave finished surface free from depressions that may collect water. The Contractor shall remove any depressions at their own expense over 1/8" deep when tested with a six-foot straight edge without evidence of patching.

C. Joining New Asphalt Pavement to Adjacent Construction

1. Carefully construct joints between old and new pavements, or between successive days work to ensure continuous bond between adjoining paving. Construct joints with the same texture, density and smoothness as adjacent sections of asphalt courses. Clean sand, dirt and other deleterious material from contact surfaces and apply tack coat.
2. Offset traverse joints a minimum of 24" between succeeding courses. Cut back pavement to the edge of previously placed courses to expose an even, vertical surface for the full course thickness.
3. Offset longitudinal joints a minimum of 6" between succeeding courses. When edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back all unsatisfactory sections to expose an even, vertical surface for the full course thickness.
4. In horizontal joints between the binder and the topcourse, clean all contact surfaces and spray a tack coat prior to the installation of the topcourse if the

binder has been in place for longer than seven days or if the pavement is determined to be excessively dirty by the Architect.

5. Seal joints with the application of asphalt cement filler, a minimum of 2″ to each side of the joint.

3.04 FIELD QUALITY CONTROL

A. Flood Tests: Perform a flood test in the presence of the Owner's Representative or the Architect utilizing a water tank truck. If a depression ponding water more than 1/8″ in depth is found, provide corrective measures to provide proper drainage.

END OF SECTION 321216

SECTION 321313 - CONCRETE PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preparation for concrete paving
B. Placement of fabric reinforcement
C. Placement of concrete
D. Placement of joints and sealants
E. Placement of detectable warning surface
F. Finishing and curing

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving
B. Section 321216 – Asphalt Paving
C. Section 321613 – Concrete Curbs

1.03 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data

1. Concrete Mix Design: Submit proposed concrete design mix together with the name and location of the batching plant.
2. Portland Cement: Brand and manufacturer's name.
3. Air Entraining Admixture: Brand and manufacturer's name.
4. Water Reducing or High Range Water Reducing Admixture: Brand and manufacturer's name.
5. Curing and Anti-Spalling Compound: Manufacturer's specifications and application instructions.
6. Welded Wire Mesh and Reinforcing Bars and Dowels: Manufacturer's name.
7. Joint Fillers and Sealants: Catalog sheets, specifications and installation instructions for each product specified.
8. ADA Detectable Warning Surface: Manufacturer's specifications, product data, test reports, method of installation, and maintenance instructions.

C. Closeout Procedures: Comply with the requirements of Section 017700.

1.04 QUALITY ASSURANCE

A. At location directed by the Architect, construct concrete flatwork sample panel approximately 5’ wide by 15’ long.

B. Concrete batching plants shall be currently approved as concrete suppliers by the New York State Department of Transportation.

C. Regulatory Requirements

1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, whichever is more stringent for methods and materials in work areas subject to applicable agency’s review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
2. Obtain written permission from applicable agencies prior to the start of construction.

1.05 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activity. Provide barricades, warning signals, warning lights, and similar items as required.

B. Environmental Conditions

1. Humidity and Moisture: Do not install the work under this specification section under conditions that are detrimental to the installation, curing and performance of the specified materials.
2. Temperature: Unless otherwise approved or recommended in writing by the sealant manufacturer, do not install sealants below 40 degrees F. or above 85 degrees F.

C. Protection: Protect all newly poured concrete surfaces from damage. Protect all surfaces adjacent to sealants with non-staining, removable tape or other approved covering to prevent soiling or staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cast-In-Place Concrete: Normal weight, air entrained concrete with a minimum compressive strength of 4,500 psi at the end of 28 days.

1. Design Air Content: ASTM C 260, and on the New York State Department of Transportation's current "Approved List"; 6% by volume +/- 1.5%.
2. Cement: ASTM C 150 Type I or II portland cement. Minimum 6.5 bags or 611 pounds per cubic yard.
3. Water: Potable.
4. Slump: Between 2 and 4 inches except when a water reducing admixture is used, the maximum slump shall be 6 inches. When a high range water reducing admixture is used, the maximum slump shall be 8 inches.
5. Water Reducing Admixture: ASTM C 494, Type A and on the current New York State Department of Transportation's current "Approved List".
6. High Range Water Reducing Admixture: ASTM C 494, Type F and on the current New York State Department of Transportation's current "Approved List".

B. Chemical Curing and Anti-Spalling Compound: Water based, acrylic polymer, Type 1, Class A (non-yellowing) compound complying with the requirements of ASTM C 1315.

1. For convenience, details and specifications have been based on the following manufacturers and their products:

a. Vocimp 25 by W.R. Meadows, Inc., Hampshire IL.
b. Super Diamond Clear VOX, Euclide Chemical Co., Inc., Cleveland, OH.
c. Cure and Seal 25% J22UV by Dayton Superior, Dayton, OH.

C. Reinforcement

1. Welded Wire Mesh: Flat sheets of welded, cold drawn steel wire epoxy coated fabric complying with ASTM A 185. Rolled wire will not be acceptable for installation as part of the project.
2. Reinforcing Bars and Dowels: Epoxy coated deformed steel bars, ASTM A 615, Grade 60.

D. ADA Detectable Warning Surface: Precast and prefabricated paving units with a non-slip texture on the travel surface. Color shall be a shade of brick red. There shall be a minimum of 70% contrast in light reflectance between the detectable warning surface and the adjoining surfaces. Material used to provide visual

warning shall be an integral part of the detectable warning surface. Visual contrast to meet the existing ADAAG A4.2.9.2.

1. For convenience, details and specifications have been based on the following manufacturers and their products:

    a. ADA Pavers: Whiteacre-Greer, Alliance, OH.
    b. Detecto-Tile: Mexcon, Worcester, NY
    c. Detectable Warning Pavers: Oaks Concrete Products, Bartlett, IL.
    d. Granite Truncated Dome Pavers: Cold Spring, MN.

E. Joint Sealants

1. For horizontal joints, two-part self-leveling polyurethane sealant for traffic bearing construction.

    a. For convenience, details and specifications have been based on the following manufacturers and their products:

        (1) Vulkem 255 by Mameco International, Inc., Beachwood, OH.
        (2) Urexpan NR-200 by Pecora Corp, Harleysville, PA.
        (3) Chem-Calk 550 by Bostik Inc., Middleton MA.
        (4) Sealtight Porthane Sealant by W.R. Meadows, Elgin, IL.
        (5) Sonolastic SL-2 Joint Sealant Slope Grade by Sonneborn Building Products Inc., Minneapolis, MN.

2. For vertical joints, two-part non-sag polyurethane sealant.

    a. For convenience, details and specifications have been based on the following manufacturers and their products:

        (1) Vulkem 227 by Mameco International, Inc., Beachwood, OH.
        (2) Dynatrol II by Pecora Corp, Harleysville, PA.
        (3) Chem-Calk 500 by Bostik Inc., Middleton MA.

F. Joint Fillers

1. Closed Cell Polyurethane Joint Filler: Resilient, compressible, semi-rigid, closed cell isometric polymer foam material, minimum ½" thick similar to Ceramar Joint Filler as manufactured by W.R. Meadows, Inc., Elgin IL.

    a. Fiber board or cork joint filler material is not acceptable for use in concrete expansion joint work.

2.02 EQUIPMENT

A. Forms: Steel of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Coat forms with non-staining, clear, paraffin-based form oil that will not discolor or otherwise stain concrete surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Surface Preparation: Remove all loose material from the compacted sub-base surface prior to placing concrete.

B. Forms: Set forms for 5" thick sidewalks unless specifically noted otherwise true to line and grade and anchor rigidly into position.

C. Space expansion joints equally at not more than 30'-0" on center.

D. Place joint filler at expansion joints and where new concrete abuts existing concrete paving and fixed structures and appurtenances. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed. Fill expansion joint with joint sealant after the concrete has been cured complying with the sealant manufacturers installation instructions.

3.03 PLACEMENT OF FABRIC REINFORCEMENT

A. Prior to placement of woven wire mesh, clean thoroughly of mill and rust scale and of coatings that could destroy or reduce bond.

B. Install fabric reinforcement midway between the top and bottom of the concrete slab. Prior to placing concrete, place fabric reinforcement midway between the top and bottom of the slab and secure against displacement with the use of chair carriers or other approved materials.

A. Lap edges and ends of adjoining sheets of fabric reinforcement at least half the mesh width. Offset end laps in adjacent sheets to prevent continuous joints at ends. Interrupt reinforcement at expansion joints, stopping 2" from edges.

3.04 PLACING CONCRETE

A. Moisten the concrete subgrade as required to provide a uniform dampened condition at the time that concrete is placed.

B. Do not place concrete around manholes or other structures until these items are brought to the required grade and alignment.

C. Consolidate concrete by spading, rodding, forking or using an approved vibrator eliminating all air pockets, stone pockets and honeycombing. Work and float concrete surface so as to produce a uniform texture.

D. Locate construction joints (if any) at expansion joint locations.

E. Deposit and spread concrete in a continuous operation between control joints.

3.05 PLACING DETECTABLE WARNING SURFACE

A. Detectable warning surfaces shall be installed 6 inches behind the edge of the curb.

B. Domes shall be aligned on a square grid in the predominant direction of travel to permit wheels to roll between the domes.

C. Install pre-cast units in accordance with the manufacturer's instructions.

D. The curb, detectable warning surface, and sidewalk shall be flush with the elevation of the road surface.

3.06 FINISHING AND CURING

A. After striking off and consolidating poured concrete, smooth the surface by screeding and floating. Adjust floating to compact the surface and produce a uniform texture.

B. After floating, test the surface for trueness utilizing a 10′ steel straight edge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Provide broom finish for walk surfaces.

D. Finish edges of walk and expansion joints with a ½″ radius edging tool. Space tool joints equally between expansion joints at approximately 5′-0″ on center, unless specifically detailed otherwise on the construction documents.

E. Apply curing and anti-spalling compound in accordance with the manufacturer's printed instructions.

F. Saw control joints one inch deep after the concrete has set. Space control joints equally between expansion joints at approximately 5′-0″ on center, unless specifically detailed otherwise on the construction documents.

3.07 FIELD QUALITY CONTROL

A. Testing by Owner of Concrete Sidewalks

1. Contractor Requirements

a. Provide access to concrete construction and concrete supplier's facilities for representatives of the testing agency employed by the Owner to perform concrete testing and facility inspections as described below.
b. Notify the Owner's Representative at least 48 hours in advance of each concrete placement to allow notification of the Owner's Testing Agency.

2. Concrete Testing During Construction by the Owner's Testing Agency

a. Sampling Method: ASTM C 172 modified for slump to comply with ASTM C94.
b. Slump Testing (ASTM C143): One test for each concrete load at the point of discharge. One test for each set of compressive strength test specimens, and one test from the middle of each load.
c. Air Content Testing (ASTM C231, Pressure Method): One of each set of compressive strength test specimens; air content checked on every fourth load of "ready-mix" concrete delivered.
d. Compressive Strength Testing

(1) Specimen Preparation: In compliance with ASTM C31 requirements to prepare one set of standard cylinders (minimum six each) for each compressive strength test.
(2) Specimen Testing: In compliance with ASTM C39 requirements for testing of one set of specimens for each 100 cubic yards (or fraction thereof) of each type of concrete placed in each day as follows

(a) Two specimens at seven days after concrete completion.
(b) Three specimens at 28 days after concrete placement.
(c) One specimen retained for later testing, if required.

e. Reporting: Reports containing the following information shall be provided in writing by the Owner's Testing Agency to the Architect and the Prime Contractor the same day the tests are accomplished.

(1) Project identification name and number.
(2) Name of prime contractor, concrete supplier and testing agency.
(3) Number (or other designation) of truck delivering the concrete.
(4) Concrete type and class, date of placement, and location of concrete batch within the project.
(5) Design compressive strength at 28 days.
(6) Concrete mix proportions and materials.
(7) Compressive breaking strength and type of break for both 7-day test and 28-day test.

f. Concrete Temperature: Test hourly when air temperature is 40 degrees F. or lower, or when the air temperature is 80 degrees F. or above, and each time compression testing specimens are prepared.
g. Inspection of Supplier Facilities: The Owner's Testing Agency may inspect the concrete supplier's batch plant and review batching procedures as deemed necessary by the Owner, including inspecting the aggregate washing facility, concrete heating system, and concrete transportation equipment.
h. Inspection of Reinforcing Steel: The Owner's Testing Agency may inspect placement of reinforcing steel. Do not begin concrete placement on any pour unless the Owner's Representative and the Architect have been notified at least one day preceding the pour to allow reasonable time for inspection of the reinforcing steel.

3.08 ADJUSTING AND CLEANING

A. Repairs and Protection of Concrete Sidewalks

1. Repair or replace broken or defective concrete as directed by the Architect.
2. Protect concrete from damage until acceptance of concrete sidewalk construction. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain walks as clean as possible by removing surface stains as they occur.
3. Sweep concrete walks and wash them free of stains, discoloration, dirt, and other foreign materials just prior to final acceptance.

B. Patching Existing Construction: Repair or patch adjacent existing concrete or other surfaces damaged from concrete sidewalk construction.

END OF SECTION 321313

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SECTION 321613 - CONCRETE CURBS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Curb installation
B. Curb cut installation

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving
B. Section 321216 – Asphalt Paving
C. Section 321313 – Concrete Paving

1.03 REFERENCES

A. Comply with ACI 301-89 for all work specified as part of this section unless specifically indicated otherwise within the Contract Documents.

1.04 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures.

B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.

C. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.

D. Closeout Procedures: Comply with the requirements of Section 017700.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements

1. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

1.06 PROJECT CONDITIONS

A. Field Measurements: Maintain required lines and elevations for grade control.

B. Existing Conditions: Maintain access for vehicular and pedestrian traffic as required for other construction activity. Provide barricades, warning signals, warning lights and similar items as required.

1.07 SEQUENCING AND SCHEDULING

A. Proceed with and complete concrete curb construction as rapidly as portions of site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Normal weight, air entrained concrete with minimum compressive strength of 4,500 psi at end of 28 days. Design air content shall be 6% by volume, with an allowable tolerance of +/-1%. Concrete shall contain a minimum of 6.5 bags of cement per cubic yard. Slump shall between 2 and 4 inches.

B. Joint Fillers: Closed Cell Polyurethane Joint Filler: Resilient, compressible, semi-rigid, closed cell isometric polymer foam material, minimum ½" thick similar to Ceramar Joint Filler as manufactured by W.R. Meadows, Inc., Elgin IL.

1. Fiber board or cork joint filler material is NOT acceptable for use in concrete expansion joint work.

C. Joint Sealants: Two-part non-sag polyurethane sealant. For convenience, details and specifications have been based on the following manufacturers and their products:

1. Vulkem 227 by Mameco International, Inc., Beachwood, OH.
2. Dynatrol II by Pecora Corp, Harleysville, PA.
3. Chem-Calk 500 by Bostik Inc., Middleton MA.

D. Reinforcing Bars and Dowels: Epoxy coated deformed steel bars, ASTM A 615, Grade 60.

2.02 EQUIPMENT

A. Forms: Steel of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Bent, twisted, split or defective form materials are not acceptable. Use flexible spring steel forms to form radius bends. Coat forms with non-staining, clear, paraffin base form oil that will not discolor or otherwise deface the surface of concrete.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which concrete curbs are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Surface Preparation: Remove all loose material from the compacted sub-base surface immediately before placing concrete. Establish and maintain required lines and grades.

3.03 INSTALLATION

A. Form Construction

1. Set approved forms true to line and grade, rigidly braced and secured. Cast curb in 30-footlong sections.
2. If curbs abut existing pavement, locate joints opposite pavement joints.
3. Profile of curb to be 18" high by 6" wide with a tooled 1½" radius on the top corner unless specifically detailed otherwise on the Contract Documents.

4. Allow forms to remain in place a minimum of 24 hours after concrete placement.

B. Joint Filler Installation: Provide joint fillers cut to size between the 30-foot sections, at the start and end of curved sections and where curbs abut existing concrete paving, fixed structures or appurtenances. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed.

C. Reinforcement Placement: Reinforce curbs as indicated on the Contract Drawings. Maintain a minimum 3" cover on all reinforcing bars.

D. Concrete Placement: Do not place concrete until line and grade of subgrade and forms have been verified. Moisten subgrade as required to a uniform dampened condition at the time concrete is placed. Do not place concrete around structures until these items are brought to the required grade and alignment. Deposit and spread concrete in a continuous operation between joints.

E. Concrete Consolidation: Consolidate concrete by spading, rodding, forking or using an approved vibrator eliminating all air pockets, stone pockets and honeycombing. Consolidate with care to prevent dislocation of dowels and joints.

F. Remove forms and rub exposed face of curb to a smooth rubbed finish. Plastering is not permitted.

G. Control Joints: Saw cut control joints at 15' O.C.

H. Concrete Curing: Cover and cure newly poured concrete curbs for a minimum of seven days in accordance with ACI 301.

I. Joint Sealant Installation: Remove temporary joint filler cap and install joint sealant per the manufacturer's recommendations.

3.04 ADJUSTING AND CLEANING

A. Repairs and Protection of Concrete Curbing

1. Repair or replace broken or defective curbing as directed by the Architect.
2. Protect concrete curbing from damage until acceptance of the curb construction.

END OF SECTION 321613

SECTION 321723 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Traffic line paint
B. Application of traffic striping and control markings

1.02 RELATED SECTIONS

A. Section 321216 – Asphalt Paving
B. Section 321313 – Concrete Paving

1.03 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures.

B. Product Data - Submit manufacturer's specifications and installation instructions.

C. Shop Drawings - Submit drawings and diagrams indicating stripe width of roadway divider stripes and parking stalls, configurations and dimensions of directional arrows, style and size of lettering, configuration and dimensions of international handicapped symbol, and any other traffic control markings on pavement as indicated on the Contract Documents.

D. Quality Control Submittals

1. Qualifications Certification - Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements of this specification.
2. Experience Listing - Submit list of completed projects using products proposed for this project, including owner's contact information and telephone number for each project.

E. Closeout Procedures - Comply with the requirements of Section 017700.

1.04 QUALITY ASSURANCE

A. Design Requirements: Comply with the applicable requirements of New York State Department of Transportation Standard Specification, Section 640 and the "National Manual on Traffic Control Devices" – 2003 Edition and the New York State Supplement.

B. Regulatory Requirements - Obtain written permission from applicable agencies prior to start of construction. Submit copy of permit as specified in "Submittals-Quality Control" above.

1.05 SEQUENCING AND SCHEDULING

A. Proceed with and complete traffic marking installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

B. Perform painting operations after working hours, on weekends or at such time so as not to interfere with the flow of traffic. Provide temporary barriers to prevent vehicles from driving over newly painted areas.

C. Apply paint on dry pavement surface when the air temperature is above 40 degrees F.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Paint - Utilize paint as indicated in NYSDOT Standard Specification, 640-2.

1. White lines shall be used to delineate the separation the traffic flows in the same direction including channelizing lines, stop lines and cross walk lines.
2. Yellow lines shall be used to delineate the separation of flows in opposing directions such as center lines on two-way roads.
3. Yellow lines shall be used to delineate parking space limit lines including lines in no parking areas and associated word and symbol markings.
4. Blue lines shall be used to delineate handicapped parking lines, international symbols and adjacent “no parking” side aisles.

B. Acceptable Products - Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:

1. “Setfast Acrylic Latex Traffic Paint” as manufactured by Sherwin Williams, Co., Cleveland, OH (Tel. #216-566-2902).
2. “Waterborne Hydrophast Traffic Paint” as manufactured by Franklin Paint Company, Inc., Franklin, MA (Tel. #508-528-0303).
3. “Traffic and Zone Marking Paint” as manufactured by PPG Porter Paints, Pittsburgh, PA (Tel. #1-800-332-6270).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions - Examine conditions under which pavement markings are to be installed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Remove dust, dirt and other foreign material detrimental to paint adhesion.

B. Mark layout of stripes and lines with chalk or paint.

3.03 APPLYING PAVEMENT MARKINGS

A. Apply paint in accordance with New York State Department of Transportation Standard Specification Section 640 - 3.02.

B. Do not apply pavement marking paint until layout, colors and placement have been verified with the Owner and the Architect.

C. Allow paving to cure for 30 days prior to starting pavement marking.

D. Clean surfaces to eliminate loose material and dust prior to applying pavement markings.

E. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at the Manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

F. At completion of pavement marking applications, the Contractor shall check all work thoroughly and shall touchup traffic control and parking stall markings that are not distinct or thorough in coverage or are not uniform in color.

3.04 ADJUSTING AND CLEANING

A. Repairs and Protection of Pavement Markings

1. Repair defective pavement markings as directed by the Architect.
2. Protect pavement markings from damage until acceptance of the installation work.

END OF SECTION 321723

SECTION 323119 - DECORATIVE METAL 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. Decorative aluminum fence swing gates.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

   1. Include plans, elevations, sections, gate locations, post spacing, and mounting attachment details.

C. Samples: For each fence material and for each color specified.

   1. Provide Samples 12 inches (300 mm) in length for linear materials.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For gate operators to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 10-foot (3-m) length of fence complying with requirements.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading:

1. Fence Height: 0 to 15 feet (0 to 4.57 m).
2. Wind Exposure Category: B.
3. Design Wind Speed: 120 mph (193 kph).

2.2 DECORATIVE ALUMINUM FENCES & GATES

A. Decorative Aluminum Fences: Fences made from aluminum extrusions.

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. Alumi-Guard, Inc.
b. Ameristar Fence Products; an ASSA ABLOY company.
c. Carfaro, Inc.
d. Delair Group, L.L.C.
e. East & West Alum Craft Ltd.
f. Elegant Aluminum Products, Inc.
g. Elite Fence Products, Inc.
h. Fortress Building Products (formerly Fortress Iron and Fortress Fence).
i. Ideal Aluminum Products.
j. Iron Eagle Industries, Inc.
k. Japra Group International.
l. Jerith Manufacturing Company, Inc.

m. Master Halco.
n. Merchants Metals.
o. Royal Aluminum and Steel, Inc.
p. Specrail.
q. Superior Aluminum Products, Inc.
r. Tek-Rail.
s. Ultra Aluminum Mfg., Inc.
t. Virginia Railing and Gates, LLC.

B. Rails: Extruded-aluminum channels, 2 by 2 inches (51 by 51 mm), with 0.100-inch- (2.54-mm-) thick sidewalls and 0.070-inch- (1.78-mm-) thick top

C. Pickets: Extruded-aluminum tubes, 1 inch (25 mm) square, with 0.062-inch (1.57-mm) wall thickness .

1. Terminate tops of pickets at radius top rail for flush top appearance.
2. Picket Spacing: **5 1/2 inches** clear, maximum.

D. Fasteners: Manufacturer's standard tamperproof, corrosion-resistant, color-coated fasteners matching fence components with resilient polymer washers.

E. Fabrication: Assemble fences into sections by welding pickets to rails.

1. Fabricate sections with clips welded to rails for field fastening to posts.
2. Drill clips for fasteners before finishing.

F. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

G. Finish: Baked enamel or powder coating.

2.3 SWING GATES

A. Gate Configuration: As indicated.

B. Gate Frame Height: As indicated.

C. Gate Opening Width: As indicated.

D. Aluminum Frames and Bracing: Fabricate members from square extruded-aluminum tubes 2 by 2 inches (51 by 51 mm) with 0.140-inch (3.56-mm) wall thickness.

E. Frame Corner Construction: Welded.

F. Additional Rails: Provide as indicated, complying with requirements for fence rails.

G. Infill: Comply with requirements for fence.

H. Picket Size, Configuration, and Spacing: Comply with requirements for fence.

I. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet (1.52 m) wide. Provide center gate stops and cane bolts for pairs of gates.

1. Fabricate latches with integral push pad exit devices for free egress through the gate from the courtyard side.
   a. Provide cylinder SFIC core locks from the secure side of the gate (cores provided by the Owner to key to building system).
2. Provide finished barrier plates around the exit devices to prevent intruders from reaching through the pickets from the secure side of the gate to release the gate latches. Provide at the gate and on the adjacent fence jambs.

J. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.
2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

K. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch- (19-mm-) diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

L. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

M. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123/A123M. For hardware items, hot-dip galvanize to comply with ASTM A153/A153M.

N. Steel Finish: High-performance coating.

O. Aluminum Finish: Baked enamel or powder coating.

2.4 ALUMINUM

A. Aluminum, General: Provide alloys and tempers with not less than the strength and durability properties of alloy and temper designated in paragraphs below for each aluminum form required.

B. Extrusions: ASTM B221 (ASTM B221M), Alloy 6063-T5.

C. Tubing: ASTM B429/B429M, Alloy 6063-T6.

D. Plate and Sheet: ASTM B209 (ASTM B209M), Alloy 6061-T6.

E. Die and Hand Forgings: ASTM B247 (ASTM B247M), Alloy 6061-T6.

F. Castings: ASTM B26/B26M, Alloy A356.0-T6.

2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for strength and compatibility in fabricated items.

B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi (20 MPa), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C387/C387M mixed with potable water according to manufacturer's written instructions.

C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

2.6 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils (0.05 mm). Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

1. Construction layout and field engineering are specified in Section 017300 "Execution."

3.3 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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, gate operators, and other moving parts.

3.6 DEMONSTRATION

A. Train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION 323119

SECTION 329200 - TURF AND GRASSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Subsoil preparation
B. Placement of topsoil
C. Seeding and application of soil amendments and fertilizers
D. Mulching
E. Protection of seeded areas
F. Turf maintenance during warranty period
G. Cleanup and protection
H. Inspections and final acceptance

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving

1.03 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Quality Control Submittals

1. Experience Listing: Submit a list of completed projects including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
2. Topsoil Analysis Report: Submit topsoil analysis report for on-site stockpiled or imported topsoil. Do not mix or utilize topsoil until a soil analysis report is approved by the Architect.

a. Provide required representative samples of topsoil and organic or inorganic amendment materials proposed for use in the project to the independent testing agency noted below for analysis and recommended treatment. The Contractor shall pay for all costs incurred for testing and analysis of the soil material. Test reports shall be from current year.

(1) All soil samples and proposed amendments shall be sent to the Owner's Testing Agent:

Turf & Soil Diagnostics - NY, Inc.
35 King Street
Trumansburg, New York 14886
Telephone Number: 607-387-5694

b. All reports shall be sent to the Architect for approval.
c. Samples of imported topsoil to be brought to the site must be approved prior to delivery.
d. Deficiencies in the topsoil shall be corrected by the Contractor, as directed by the Architect, after review of the testing agency report.
e. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil additives and fertilizers based upon soil test results and type of seed mix to be planted. Follow soil additive recommendations before and during topsoil respread operations. Include the following in the topsoil analysis:

(1) pH factor
(2) Percent organic matter as determined by a Loss on Ignition or Walkey/Black Test (ASTM F-1647.
(3) Proctor testing per ASTM D698.
(4) Chemical analysis testing nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).
(5) Particle size analysis of the topsoil as determined by ASTM F-1632, performed and compared to the USDA Soil Classification System.

f. Include in the recommendations the type, composition, rate and means of application of soil amendments and fertilizer necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting.
g. All materials and procedures regarding soil amendments and fertilizers specified in this section are approximate; adjust all soil amendments to comply with the test reports.

3. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

C. Contract Closeout Submittals: Comply with the requirements of Section 017700.

1.04 QUALITY ASSURANCE

A. Worker's Qualifications: The person's performing turf grass related installations and supporting work and their direct supervisor shall be personally experienced in the construction and caring of lawn areas. On site supervisory personnel shall have been employed by the company engaged in the installation and care of lawn areas for a minimum of five years. All other individuals on the landscape crew must have a minimum of six months experience in the landscape contracting industry.

1.05 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Ship seed and associated materials with certificates of inspection required by governing authorities.

B. Do not make substitutions. If specified seed material is not obtainable, submit to the Project Designer proof of non-availability and a proposal for use of equivalent material.

C. Store all seed at the site in a cool, dry place as approved by the Owner's Representative. Replace any seed damaged during storage.

D. Deliver seed in vendor's unopened packages bearing labels showing the vendor's name and seed analysis by weight.

E. Deliver fertilizer in the manufacturer's standard sized bags showing the weight, analysis, and manufacturer's name. Store all fertilizer under a waterproof cover or in a dry place as approved by the Owner's Representative.

1.06 PROJECT CONDITIONS

A. Water: If available on the site, water will be supplied for the purpose of watering newly planted lawn areas at no cost to the contractor. If water is not available on site, the contractor shall supply water at their own cost as required to maintain the health of the newly planted material.

B. Provide irrigation materials capable of adequately watering new lawn areas until acceptance.

1.07 PESTICIDE APPLICATIONS

A. Any contractor applying pesticides must notify the Owner's designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including herbicides, insecticides and fungicides in accordance State Regulations and the School Pesticide Neighbor Notification

Law, Section 409-H of the New York State Education Law and Commissioner's Regulation 155.24.

1.08 SEQUENCING AND SCHEDULING

A. Proceed with and complete lawn planting as rapidly as portions of the site become available, working within seasonal limitations for the work required.

B. Seed lawn areas during a period between August 15 and October 1. Seeding during unseasonable conditions must be reviewed and approved with the Architect at the sole risk of Contractor.

C. The Contractor shall complete a minimum of three mowings before requesting the Project Designer review for acceptance of seeding work.

PART 2 PRODUCTS

2.01 SEED

A. Grass seed shall be certified "Blue Tag" seed composed of a blend of varieties mixed in proportion by weight and tested for minimum percentages of purity and germination. Submit the proposed mixture to the Architect for approval.

1. Fall Seeding: Seed blend shall consist of 100% Kentucky Bluegrass on a weight basis. The seed shall be a blend of at least three Kentucky Bluegrass varieties of which no less than 60% of the seed shall be at least two of the following cultivars; Rambo, Princeton-105, Wildwood, Allure, Coventry, Champagne, Northstar, Cardiff, Nimbus, Raven, SR2100, Misty, America, Brilliant, Limousine, Conni, Liberator, Apollo, NuGlade, Total Eclipse, Unique, Impact, Midnight, Arcadia and Serene.

2. Spring Seeding (If approved by the Project Designer): Seed blend shall consist of 80% Kentucky Bluegrass and 20% Perennial Ryegrass on a weight basis. The seed shall be a blend of at least two Kentucky Bluegrass varieties of which no less than 60% of the seed shall be at least two of the following cultivars; Rambo, Princeton-105, Wildwood, Allure, Coventry, Champagne, Northstar, Cardiff, Nimbus, Raven, SR2100, Misty, America, Brilliant, Limousine, Conni, Liberator, Apollo, NuGlade, Total Eclipse, Unique, Impact, Midnight, Arcadia and Serene. The Perennial Ryegrass may be any one of the following cultivars; Palmer III, Calypso II, Brightstar II, Secretariat, Monterey, Catalina, Pennant II, Premier II, Sonata, Sunshine and Ascend. The Perennial Ryegrass shall have a minimum germination percentage of 85%. The percentage of weed seed shall not exceed 1% and other crop seed shall

not exceed 0.5% by weight of the mixture. Any variety substitutions or deviations from these specifications must be approved by the Architect.

2.02 TOPSOIL

A. Use either approved topsoil imported to the project site or approved on-site topsoil stripped, stockpiled and amended to meet the required specifications.

1. On-site topsoil shall be from existing stockpiles stripped from the project site and approved by the Architect.
2. Where quantity of topsoil required exceeds that available from on-site stockpiles, provide imported topsoil from local sources or from areas having similar soil characteristics to that found on the project site which are producing or have produced fair to good yield farm crops without unusual fertilization for a minimum period of ten years or from arable or cultivable areas supplied with good natural drainage. Do not obtain topsoil from bogs or marshes or from farmland that has utilized "Atrizine" or similar herbicide within the past five years.

B. Provide topsoil conforming to the following:

1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.
2. Containing not less than four percent nor more than 20 percent organic matter in that portion of a sample passing a ¼" sieve when determined by the wet combustion method on a sample dried at 105 degrees F.
3. Containing a pH value within the range of 6.3 and 7.0 on that portion of the sample which passes a ¼" sieve.
4. On-site and imported topsoil shall be mechanically screened prior to respreading to comply with the following gradation:

SIEVE DESIGNATION	PERCENT PASSING
¾ inch	100
¼ inch	97 – 100
No. 200	20 - 65

2.03 FERTILIZER

A. Mixed commercial fertilizers containing total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-6-4 (50% N/UF). 50% of the total nitrogen shall be derived from a urea form furnishing a minimum of 3.5% water insoluble nitrogen (3.5% WIN). The balance of the nitrogen shall be present as methylene urea, water soluble urea, nitrate and ammoniacal compounds.

2.04 LIME

A. Dolomitic Limestone: Approved agricultural dolomitic limestone containing no less than 50% of total carbonates and 25% total magnesium with a neutralizing value of at least 100%. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.

B. Calcitic Limestone: Approved agricultural calcitic limestone containing a minimum of 86% calcium carbonate expressed as CaCO3. The material shall be ground to such a fineness that 40% will pass through a number 100 U.S. standard sieve, and 98% will pass through a number 20 U.S. standard sieve. The lime shall be uniform in composition, dry and free flowing and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Any lime which becomes caked or otherwise damaged making it unsuitable for use will be rejected.

2.05 MULCH

A. Dry Application Straw: Stalks of oats, wheat, rye or other approved crops which are free from noxious weeds. Weight shall be based on 15% moisture.

B. Hydro-Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch.

1. For convenience, details and specifications have been based on the following manufacturers and their products:

a. Conwed Hydro Mulch as manufactured by Conwed Fibers, Hickory NC.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which lawn installation is to be completed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the

Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable, to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Strip and stockpile full depth of existing topsoil. Screen topsoil to comply with gradation specifications prior to respread of the material.

B. Perform earthwork operations to accomplish design elevations as indicated on the Contract Documents. Loosen subgrade of lawn areas to a minimum depth of four inches. Remove stone and any other deleterious matter encountered over 1½" in any dimension within the subgrade.

C. Respread screened topsoil in general lawn areas (non-playfield areas) to a minimum depth of six inches as required to meet lines, grades, and elevations shown after light rolling and settlement.

D. Provide lime or sulfur as required to adjust pH of the screened topsoil to be 6.3 to 7.0. Apply lime or sulfur materials at a rate of 80 pounds per 1000 square feet (final application rate to be determined by the soil test report). Cultivate soil amendments to a four-inch depth.

E. Grade lawn areas to a smooth even surface with loose, uniformly fine texture. Roll, rake, remove ridges and fill depressions as required to meet finish grades. Limit fine grading operations to areas which can be planted immediately after grading.

F. Moisten prepared lawn areas before seeding if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

G. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to seeding.

H. Preparation of Unchanged Grades: Where lawns are to be seeded in areas that have not been altered or disturbed by excavating, grading, or stripping operations, prepare the soil bed for lawn planting as follows:

1. Prior to preparation of unchanged grades, remove existing grass, vegetation and turf. Dispose of such material outside of the Owner's property; do not turn over into the soil being prepared for lawns unless specifically indicated to do so on the Contract Drawings.
2. Till soil to a depth of not less than six inches.
3. Apply soil amendments and initial fertilizers as recommended.
4. Remove high areas and fill in depressions.
5. Till soil to a homogeneous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

3.03 SEEDING

A. Do not use wet seed or seed which is moldy or otherwise damaged in transit or storage.

B. Application Rate: Six pounds of seed per 1000 square feet.

C. Dry Mechanical Application of Seed: Sow seed with Brillion seeder with notched rollers in three passes, second pass at 90 degrees to the first and the third at 45 degrees to the second. Sow at a rate of two pounds per 1000 square feet for each pass for a total of six pounds per thousand square feet. Incorporate the seed into the upper one inch of the prepared soil bed and water with a fine spray.

D. Hydroseeding

1. Apply seeding material with an approved hydroseeder.
2. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch and seed to obtain the specified application rate. Maintain constant agitation to keep the contents in a homogeneous suspension. Prolonged delays in application or agitation that may cause injury to the seed will be the basis for rejection of the material remaining in the tank.
3. Distribute uniformly a slurry mixture of water, seed, fertilizer and mulch at a minimum rate of 57 gallons per 1000 square feet. (2500 gallons per acre). The Owner's Representative may order the amount of water increased if distribution of seeding materials is not uniform.

3.04 MULCHING

A. Dry Application: Immediately following seeding operations cover seeded areas with a uniform blanket of shredded straw mulch mechanically blown at a rate of 100 pounds per 1000 square feet of seeded area.

B. Hydro Application: Apply approved mulch in accordance with the manufacturer's written instructions and recommended rates of application.

3.05 PROTECTION OF SEEDED AREAS

A. Where grade is less than 3:1, mechanically spread mulch material and crimp into soil utilizing approved disc type machinery with rows at a 6" spacing.
B. Where grade is 3:1 or greater, cover seeded areas with jute matting and roll matting down over the slopes without stretching or pulling.

    1. Lay the jute matting smoothly on the soil surface, burying the top end of each section in a narrow six-inch trench. Leave a 12-inch overlap from the top roll over the bottom roll. Leave a four inch overlap over the adjacent section.
    2. Staple outside edges and overlaps at 36-inch intervals.
    3. Lightly dress slopes with topsoil to ensure close contact between the matting and the soil layer below.
    4. In ditches, unroll matting in the direction of flow. Overlap ends of strips six inches with the upstream section on the top.

3.06 MAINTENANCE

A. Begin maintenance immediately after seeding. If seeded in the fall, continue maintenance the following spring until acceptable lawn conditions are established.

B. Water to ensure proper seed germination and to keep the surface of the seed bed damp. Continue watering new seeding until acceptance by the Owner. Apply water slowly so that the surface of the soil will not puddle or crust.

C. Cut grass for the first time when it reaches a height of 2½" and maintain a minimum height of 2". Do not cut more than 1/3 of the blade at any one mowing. Remove clippings.

D. Apply herbicide as soon as weeds germinate, during calm weather when the air temperature is above 50 degrees F. using a licensed applicator to apply the herbicide. When using herbicides, apply in accordance with the manufacturer's instructions.

E. Replant damaged grass areas showing root growth failure, deterioration, bare spots and eroded areas.

F. Refertilize newly seeded areas 28 days after the initial seeding. Apply a minimum of one pound of nitrogen per 1000 square feet of athletic field area. Use a complete fertilizer with a 2-1-1 ratio or as recommended by soil test results.

3.07 CLEANUP AND PROTECTION

A. During landscape construction work, keep pavements clean and the project area in an orderly condition.

B. Protect landscape construction and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape construction as directed.

3.08 INSPECTIONS AND FINAL ACCEPTANCE

A. When seeding work and lawn establishment is completed, (including maintenance), request the Architect to make an inspection to determine acceptability. Final acceptance of lawn areas will be granted when a uniform stand of acceptable grass is obtained with a minimum of 95% coverage.

B. Where inspected lawn installation does not comply with the requirements of the Contract Documents, repair rejected work. The Contractor's maintenance responsibility shall continue until reinspected by the Architect and found acceptable. Maintenance responsibilities shall include refertilization, overseeding, watering and mowing of seeded areas.

END OF SECTION 329200

SECTION 329300 - EXTERIOR PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Inspection of plant material
B. Preparation for planting
C. Installation of plants
D. Follow-up inspections and replacements of plants

1.02 RELATED SECTIONS

A. Section 312000 – Earth Moving
B. Section 329200 – Turf and Grasses

1.03 REFERENCES

A. Plant Nomenclature: Conform to the latest edition of "Standardized Plant Names" as adopted by the American Joint Committee of Horticultural Nomenclature.

B. Size and Grading Standards: Conform to the current edition of "American Standard for Nursery Stock" by the American Association of Nurserymen, Inc., unless otherwise specified.

1.04 DEFINITIONS

A. Weeds: Vegetative species other than specified species to be established in given area.

B. Plants: Living trees, shrubs, perennials, ground cover, and other plant material specified in this section.

1.05 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. List of plants: Before plant material is shipped to the project site, submit a complete itemized list of all plants including the source of supply.

C. Product Data: Furnish the following with each planting material delivery:

1. Invoice indicating sizes and varieties of plant material.
2. Certificates of inspection required by State and Federal agencies.
3. Labels for each plant or bundles of plants indicating name and size.

D. Quality Control Submittals

1. Experience Listing: Submit a list of completed projects including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.
2. Planting Soil Analysis Report: Submit planting soil analysis report for on-site stockpiled or imported planting soil. Do not mix or utilize planting soil until a soil analysis report is approved by the Architect.

    a. Provide required representative samples of planting soil materials proposed for use in the project to an independent testing agency for analysis and recommended treatment. Contractor shall pay for all costs incurred for testing and analysis of the soil material.
    b. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil additives and fertilizers based upon soil test results and type of material to be planted. Follow soil additive recommendations during all planting operations. Include the following in the planting soil analysis:

        (1) pH factor
        (2) Percent organic matter
        (3) Soluble salts
        (4) Available macro and micro nutrients
        (5) Percent clay, sand and silt particles

    c. Include in recommendations the type, rate and means of application of soil amendments and fertilizer necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting.
    d. All materials and procedures regarding soil amendments and fertilizers specified in this section are approximate; adjust all soil amendments to comply with the test reports.

E. Contract Closeout Submittals: Comply with the requirements of Section 017700.

1.06 QUALITY ASSURANCE

A. Worker's Qualifications: The person's performing the planting and their direct supervisor shall be personally experienced in the planting and caring of plant material. On site supervisory personnel shall have been employed by the company engaged in the planting and caring for a minimum of two years. All other individuals on the landscape crew must have a minimum of six months experience in the landscape contracting industry.

B. Tree Caliper

1. Trees up to four inches in caliper shall be sized at a point six inches above the top of the root ball.
2. Trees over four inches in caliper shall be sized at a point 12 inches above the top of the root ball.

C. Inspection: The Architect reserves the right to inspect plant material either at the nursery or on the project site before planting for compliance with the requirements for name, variety, size and quality.

1.07 DELIVERY, STORAGE AND HANDLING

A. Notify the Owner's Representative a minimum of 48 hours in advance of delivery of plant material.

B. Do not make substitutions. If specified plant material is not obtainable, submit to the Architect proof of non-availability and a proposal for use of equivalent material. When authorized, adjustment of the contract amount will be made.

C. Protect plant material against climatic and mechanical injury.

D. Acceptance of Plant Material at the Project Site

1. Provide freshly dug trees and shrubs. Do not prune prior to delivery. Do not bend or bind tie trees or shrubs in such a manner as to damage bark, break or destroy the natural shape of the plant material. Provide protective covering during delivery.
2. Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than six hours after delivery, set trees and shrubs in the shade, protect from weather and mechanical damage and keep roots moist.
3. Label at least one tree and shrub of each variety with a securely attached waterproof tag bearing a legible description of the botanical and common name of the plant material.

4. Reject plants when the ball of earth surrounding the roots has cracked or broken prior to or during the planting process.
5. Reject plants when burlap, staves, and ropes required in connection with transplanting have been displaced prior to acceptance.

E. Deliver fertilizer in the manufacturer's standard sized bags showing the weight, analysis, and manufacturer's name. Store all fertilizer under a waterproof cover or in a dry place.

1.08 PROJECT CONDITIONS

A. Water: If available on the site, water will be supplied for the purpose of watering newly planted material at no cost to the contractor. If water is not available on site, the contractor shall supply water at their own cost as required for to maintain the health of the newly planted material.

B. Utilities: Determine the location of underground utilities and perform work in a manner avoiding possible damage, including required hand excavation. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned.

C. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owner's Representative before planting.

1.09 PESTICIDE APPLICATIONS

A. Any contractor applying pesticides must notify the Owner's designated pesticide representative and all property neighbors not less than 48 hours in advance of any pesticide application including herbicides, insecticides and fungicides in accordance State Regulations and the School Pesticide Neighbor Notification Law, Section 409-H of the New York State Education Law and Commissioner's Regulation 155.24.

1.10 PLANTING GUARANTEE

A. The plant guarantee shall extend for a period of one full year from the date of substantial completion of the work. Substantial completion for the work of this section is the date when all planting operations or seasonal portions of the planting operations or replacement operations have been completed and are accepted by the Owner's Representative or the Architect.

1. The Contractor shall arrange for and conduct a final inspection with the Owner or the Owner's Representative at the end of the one-year guarantee period.
2. Replace plant materials found dead or in an unhealthy or unsightly growing condition and that have lost their natural shape due to dead branches or other causes due to the Contractor's negligence at the Contractor's expense.
3. Replace with plant materials of the same size and species and with a new guarantee period commencing on the date of replacement.
4. Provide maintenance and additional watering for an additional 12-month period.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. Shrubs and Trees: The Contractor shall provide plant material complying with the following:

1. Nursery grown stock as indicated in the itemized plant list or on the Contract Documents complying with the recommendations and requirements of ANSI Z60.1 "Standard for Nursery Stock" and as specified.
2. Acclimated plants true to genus and species grown in recognized nurseries in accordance with good horticultural practices.
3. Well developed root and branch systems. Do not prune branches before delivery.
4. Free of disease, insect eggs, bark abrasions, frost cracks, dead or broken branches and disfiguring knots.
5. Buds intact and reasonably closed at the time of planting.
6. Balled and burlapped from soil which will hold a natural ball. Manufactured balls are unacceptable.
7. Conform to size indicated or larger, or within the minimum/maximum size when so indicated. Larger plants cut back to specified dimensions will not be acceptable.
8. Specified trees shall have a single erect leader from ground to top, surrounded with uniformly arranged branches unless specifically noted otherwise.
9. Transplanted or root pruned 360 degrees at least once during the previous three years.

2.02 PLANTING SOIL

A. Use either approved planting soil imported to the project site or approved on-site topsoil stripped, stockpiled and amended to meet the required specifications.

1. Topsoil for Planting Soil meeting the following specifications: Sand 35%-60%, Silt 30%-35%, and Clay 10%-25%.

B. Soil Amendments (For every 4CY of topsoil):

1. Peat Moss: 7½ CF bale (Approved compost material may be used as a substitute to peat moss).
2. Fertilizer: 5lbs.

2.03 FERTILIZER

A. 10-6-4 Commercial Fertilizer: Containing not less than 10% nitrogen, 6% available phosphoric acid and 4% water soluble potash. (Existing topsoil analysis shall be utilized to verify the actual fertilizer analysis to be used in this project)

2.04 MULCH

A. Shredded Hardwood Mulch: Wood fiber produced from hardwood trees, free of tannic acid, leaves, young green growth, wood shavings, sawdust or other objectionable foreign material.

2.05 MISCELLANEOUS MATERIALS

A. Stakes, Deadmen and Guy Stakes: Sound, durable white or red cedar or other approved wood, free of insect and fungus infestation.

B. Guy Wire or Cable: No. 12 galvanized wire or cable.

C. Tree Wrapping: 4 inch wide strips of jute burlap or waterproof paper.

D. Protective Hose: Two-ply garden hose cut to required lengths to protect tree trunks from damage from wire.

E. Anti-Desiccant: Emulsion type, film forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with the manufacturer's instructions; similar to "Wilt-Pruf" by Wilt-Pruf products, Essex, CT.

F. Landscape Fabric: Weather resistant, polypropylene sheeting complying with the permeability coefficient 0.0028 or 2.845 gal./sf/minute, minimum 30 mil thick; similar to "Weed Barrier" by DeWitt Co., Inc., Sikeston, MO.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which landscape planting is to be completed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable, to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Planting Layout:

1. Stake out all tree locations and planting areas.
2. Obtain layout approval from the Owner's Representative prior to excavations of plant pits and beds.

B. Plant Pit Dimensions:

1. Balled and Burlapped Plants: Pit depth should not exceed the ball depth. The pit width measured at the ground surface shall be three times the width of the ball or as indicated.
2. Container Grown Plants: Two times the diameter of the container measured at the ground surface.

C. Excavation: Excavate pits to the dimensions specified. Dispose of excavated material of the site unless otherwise directed.

3.03 PLANT INSTALLATION

A. Setting Plants

1. Backfill pits with planting soil and firm to the level upon which plants were previously growing. Set plants plumb. Plant budded or grafted plants two inches below the bud or graft line. Complete backfilling with planting soil and settle continually with water.

2. Balled Plants: Set plants in position and backfill 1/3 depth of ball. Remove burlap from the top and adjust to eliminate air pockets. Remove all metal caging and synthetic twine. Complete backfill and settle with water.

B. Wrapping: Wrap deciduous trees within four days after planting from the ground line to the height of the second branches. Wrap in a single layer wound spirally starting from the base and overlapping 1½ inches. Secure wrapping in place by use of approved staples or other approved methods and materials.

C. Staking: Set tree stakes into solid ground below the bottom of the plant before backfilling. Place stakes at the outer edge of the roots or ball in line with the prevailing wind at a ten-degree angle from the tree trunk.

D. Anti-Desiccant: Apply anti-desiccant spray to broadleaved ericaceous plants installed in the Fall season, as directed.

E. Landscape Fabric: Install over the planting area to the limits indicated. Cut fabric as required to avoid plants.

F. Surface Finish: Form saucer as indicated on drawings or as directed. Grade soil to form a basin on the lower side of sloped plantings, which will catch and retain water. Topdress basins with fertilizer spread evenly at a rate of 1½ pounds per square yard of plant pit surface.

G. Mulching: Spread a minimum of 4" of shredded hardwood mulch over the finished surface of each plant, plant bed or hedge trench. Water plants thoroughly after mulching is complete.

H. Pruning: Prune plant material immediately after planting using sharp tools approved by the Owner's Representative. Remove approximately 1/3 of the wood of deciduous plants, maintaining the natural habit of the plant. Cut no leaders.

I. Guying: Secure deciduous trees two inches and over in caliper, multi-stemmed trees six feet and over in height, and evergreen trees six feet and over in height with minimum three guys. Attach guy wires with protective hosing to stakes and trees as indicated. Connect multi-stemmed trees with protected wires maintaining each stems relationship to one another.

J. Establishment of Planting: Maintain plantings immediately following planting operations and continue throughout the warranty period. Establishment of plantings shall consist of keeping plants in healthy growing conditions by watering, weeding, cultivating, pruning, spraying, tightening of guys, remulching and by any other necessary operations for establishment. Water all plants at least

once a week between April 1 and October 31 with approximately five gallons of water per square yard (one inch layer of water) per watering unless otherwise directed by the Owner's Representative. Provide additional water during periods of dry weather when required or when directed. Treat plants with sound horticultural preventative or remedial measures to control insects, diseases and rodents.

K. Weeding: Schedule maintenance work at least three times during the growing season of the 12-month warranty period to keep planting areas free from weeds. Coordinate maintenance work with the Owner's Representative.

3.04 CLEANUP AND PROTECTION

A. During landscape construction work, keep pavements clean and the project area in an orderly condition.

B. Protect landscape construction and materials from damage due to landscape operations, operations by other contractors, trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged landscape construction as directed.

3.05 INSPECTIONS AND REPLACEMENTS

A. Substantial Completion Inspection and Replacements: Notify the Owner's Representative in writing at least ten days prior to the requested date of planting substantial completion inspection. Remove and replace dead, unhealthy, or badly impaired plants according to the original specification, if so directed. Replace plants during the next planting season if this inspection is not within a planting season.

B. End of Warranty Inspection and Replacements: Remove stakes, guy wires and tree wrapping at the end of the one-year warranty period unless otherwise directed. Remove and replace dead, unhealthy or impaired plants according to the original specifications, as directed. Replace plants during the next planting season if this inspection is not within a planting season.

END OF SECTION 329300

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SECTION 333000 - SANITARY SEWER SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes furnishing all labor, materials, equipment and services required to complete and make fully functional, the work indicated on the Contract Drawings and as described in the Contract Documents. Work includes, but is not limited to the following:

1. Furnishing all work not required in other sections to complete and make operational the sewer system outside the building.
2. Sanitary sewer gravity.
3. Connections to the building sewer laterals after the cleanout.

1.2 RELATED DOCUMENTS

A. Excavation, bedding and backfill required for pipe and manhole installation is specified in Division 31 Specification Section 312000 “Earthwork-Site”.

1.3 SUBMITTALS

A. General: Submit each item to be used as part of the work for this section according to the Conditions of the Contract and Division 1 Specification Sections.

B. Shop drawings: Submit shop drawings and product data for sanitary sewer systems, showing piping materials, size, locations, and inverts. Include details of underground structures connections, and cleanouts.

C. Record Drawings: At project closeout, submit Record Drawings of installed sanitary sewerage piping and products, in accordance with requirements of General Conditions.

D. Inspection and test reports are specified in sub section 3.10, Field Quality Control.

1.4 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of sanitary sewerage and drainage system products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer Qualifications: Firm with at least three (3) years of successful installation

experience on projects with sanitary sewerage and drainage work similar to that required for Project.

C. Codes and Standards:

1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of sanitary sewerage system materials and products.
3. New York State Regulation Compliance: Comply with the rules, regulations and standards of the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC) pertaining to sanitary sewer systems.

1.5 PROJECT CONDITIONS

A. Refer to utility plans of Contract Drawings pertaining to existing above ground and underground utilities.

B. Field verify conditions at existing manholes or sanitary lines to remain which are scheduled to connect with proposed structures or pipes. Notify the Owners Designated Representative of any conditions varying from those indicated on the survey.

C. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without Construction Manager's written permission.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe or fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate sanitary sewerage system connections to related structures and building piping.

B. Coordinate with interior building drainage systems to avoid conflicts.

C. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PVC PIPES AND FITTINGS

A. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 26 gravity sewer pipe, non-perforated, for elastomeric gasket joints.

1. Gaskets: ASTM F 477, elastomeric seal.

2.3 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined, for nonpressure joints.

1. Sleeves for Cast Iron Soil Pipe: ASTM C 564, rubber.
2. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Sleeves for Dissimilar Pipes: Compatible with pipe materials being joined.
4. Bands: Stainless steel at least one at each pipe insert.

B. Gasket-Type Pipe Couplings: Rubber or elastomeric compression gasket, made to match outside diameter of smaller pipe and inside diameter or hub of adjoining larger pipe, for nonpressure joints.

1. Gaskets for Cast Iron Soil Pipe: ASTM C 564, rubber.
2. Gaskets for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Gaskets for Dissimilar Pipes: Compatible with pipe materials being joined.

2.4 SANITARY MANHOLE

A. Precast Concrete Manholes: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for rubber gasket joints.

1. Diameter: 48-inches minimum unless otherwise required.
2. Base Section: 8-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
3. Riser Sections: 5-inch minimum thickness, of length to provide depth indicated.
4. Top Section: Flat slab top unless eccentric cone type or concentric cone is indicated. Top of cone of size that matches grade rings.
5. Joint Sealant: ASTM C990, butyl sealant joint sealer, PGS-951, or approved equal.
6. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter

matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

7. Steps: ASTM C 478-85a and C497-85 individual steps manufactured of copolymer polypropylene plastic, with a #4 grade 60 steel reinforcement.
8. Resilient Connectors: ASTM C 923, of size required for piping, fitted into inlet and outlet openings: by Lockjoint, Kor-N-Seal or equal with stainless steel band clamp.
9. Structure Coating: Bitumastic coating, PGS-96, or approved equal.

B. Frame and Cover:

1. Description: Ferrous; 30-inch ID by 6 to 9-inch riser, with 4-inch minimum-width flange and 32-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 48, Class 35 gray iron unless otherwise indicated.
3. Meets requirements of AASHTO M306 to be classified as heavy duty.

2.5 CLEANOUT TO GRADE

A. Cleanout as detailed on Construction Drawings. Cleanout shall be Polyvinyl Chloride (PVC) with a ferrous metal cleanout cap. Lettering on cover to read "SEWER".

1. Available manufacturers:
   a. Neenah Foundry Company, No. 1975-A, 2121 Brooks Ave., Neenah, WI 54956, (800) 558-5075.
   b. Syracuse Castings Company, No. 4155, 6177 South Bay Road, Cicero, NY 13039, (315) 699-2982.
   c. Or approved equal.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33 crushed gravel.
4. Water: Potable.

PART 3 - EXECUTION

3.1 GENERAL

A. Work of this part shall include furnishing all required materials, manpower, tools and equipment necessary to complete the installation of the Sanitary Sewer System as described herein and shown on the drawings and shall include all materials described in

Part 2 unless approved otherwise in advance in writing.

3.2 EARTHWORK

A. Excavating, trenching and backfilling are specified in Division 31, Section 312000 "Earthwork-Site."

3.3 IDENTIFICATION

A. Materials and their installation are specified in Division 31, Section 312000 "Earthwork-Site." Furnish and install green warning tapes directly over piping at proper depth for location by detection equipment and at outside edges of underground structures.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.4 SANITARY SEWER PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.

1. Pipe Sizes: 4 and 6 inches: Polyvinyl chloride (PVC) sanitary sewer pipe and fittings; with gaskets and gasketed joints.

3.5 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:
    a. Straight-pattern, sleeve type to join piping, of same size, with small difference in outside diameters.
    b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
    c. Gasket type to join piping of different sizes where annular space between smaller piping's outside diameter and larger piping's inside diameter permits installation.
    d. Internal-expansion type to join piping with same inside diameter.

3.6 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sanitary sewer systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where fittings are indicated. Use fittings for branch connections, except where direct tap into existing sanitary sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

3.7 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following.

1. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:
   a. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
   b. Join pipe and gasketed fittings with elastomeric seals according to ASTM D3212.
2. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

3.8 MANHOLE

A. Connections to all manholes shall be core drilled and booted. These taps shall be cored into the manhole between the spring line of the sewer or no more than 24 inches above the flow line.

B. Where existing sanitary sewer manholes are constructed of brick, cobblestone, or other

materials determined by the Owner's Designated Representative that cannot be core drilled, pipes shall be grouted into the sanitary sewer manhole wall with non-shrink grout and a water seal. The water seal shall be placed continuously around the pipe to form a seal. The water seal shall be a butyl rubber rope type material.

C. The flow channel through manholes shall be U-shaped at a minimum width equal to the diameter of the pipe extending between the pipe inverts. The benchwall shall have a slick finish.

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.9 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.
2. Place plug in end of incomplete piping at end of day and whenever work stops.
3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of the Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visual between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
    c. Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into sanitary sewerage piping.
    e. Exfiltration: Water leakage from or around sanitary sewerage piping.
3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

C. Test new piping systems and parts of existing systems that have been altered, extended, or repaired for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 48 hours advance notice.
4. Submit separate reports for each test.
5. Where authorities having jurisdiction do not have published procedures, perform tests as follows:
    a. Sanitary Sewer: Perform air test according to UNI-B-6 and ASTM C828.
    b. Plug Installation and Testing: After a manhole-to-manhole reach of pipe has been backfilled to final grade, prepared for testing and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.
    c. It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.
    d. It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important in high groundwater situations.
    e. When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probably point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.
    f. Line Pressurization: Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 psig. If groundwater is present, refer to Section 8 of UNI-B-6-98 – "Determination of Ground Water Elevation and Air Pressure Adjustment."
    g. Pressure Stabilization: After a constant pressure of 4.0 psig (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.
    h. Timing Pressure Loss: When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater back pressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average back pressure of any groundwater over the pipe). At a reading of 3.5 psig, or any convenient observed pressure reading between 3.5 psig and 4.0 psig (greater than the average groundwater back pressure), timing shall commence with a stop watch or other timing device that is at least 99.8 percent accurate.
    i. A predetermined required time for a specified pressure drop shall be used to determine the lines acceptability. Traditionally, a pressure drop of 1.0 psig has been specified. However, other pressure drop values may be specified, provided that the required holding times are adjusted accordingly. If the specified pressure drop is 0.5 psig rather than the more traditional 1.0 psig, then the required test times for a 1.0 psig pressure drop must be halved.
    j. Specifying a 0.5 psig pressure drop is desirable in that it can reduce the time

needed to accomplish the air test without sacrificing test integrity. Therefore, the following subsections contain provisions for both the traditional 1.0 psig pressure drop and the more efficient 0.5 psig pressure drop. All requirements for a specified 0.5 psig drop are given in parentheses. To provide further efficiencies in testing, there is a zero pressure drop option. If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete.

k. Determination of Line Acceptance: If the time shown in Table I (or Table II), for the designated pipe size and length, elapses before the air pressure drops 1.0 psig (or 0.5 psig); the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the 1.0 psig (or 0.5 psig) drop has not occurred.

l. If there has been no leakage (zero psig drop) after one hour of testing; the section undergoing test shall have passed and shall be presumed free of defects. If there has been any pressure drop, the test shall continue as specified in above.

m. Determination of Line Failure: If the pressure drops 1.0 psig (or 0.5 psig) before the appropriate time shown in Table I (or Table II) has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

6. Leaks and loss in test pressure constitute defects that must be repaired.
7. Replace leaking piping using new materials and repeat testing until leakage is within allowances specified.

TABLE I

MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

1 Pipe Diameter (in.)	2 Minimum Time (min: sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46
42	39:48	57	41.883 L	69:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07
48	45:34	50	54.705 L	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17
54	51:02	44	69.236 L	115:24	173:05	230:47	288:29	346:11	403:53	461:34	519:16
60	56:40	40	85.476 L	142:28	213:41	284:55	356:09	427:23	498:37	569:50	641:04

Note: If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete. (See Section 7.5.)

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TABLE II

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

1 Pipe Diameter (in.)	2 Minimum Time (min: sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7.05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:54	57	20.942 L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	22:47	50	27.352 L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09
54	25:31	44	34.618 L	57:42	86:33	115:24	144:15	173:05	201:56	230:47	259:38
60	28:20	40	42.738 L	71:14	106:51	142:28	178:05	213:41	249:18	284:55	320:32

Note: If there has been no leakage (zero psig drop) after one hour of testing, the test section shall be accepted and the test complete. (See Section 7.5.)

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END OF SECTION 333000