Project Manual
Volume 2 of 2

Divisions 21-33

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ADDITIONS & ALTERATIONS AT THE
ARDEN HILL CAMPUS - REGIONAL EDUCATION CENTER
4 HARRIMAN DRIVE, GOSHEN, NY 10924

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THE UNDERSIGNED CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE, INFORMATION AND BELIEF, THE PLANS AND SPECIFICATIONS ARE IN ACCORDANCE WITH APPLICABLE REQUIREMENTS OF THE NEW YORK STATE UNIFORM FIRE PREVENTION AND BUILDING CODE, THE STATE ENERGY CONSERVATION CONSTRUCTION CODE, AND BUILDING STANDARDS OF THE EDUCATION DEPARTMENT, AND THAT THE PLANS AND SPECIFICATIONS REQUIRE THAT NO ASBESTOS CONTAINING MATERIAL SHALL BE USED.

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SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Work of this Section includes:
   1. Motors.
   2. Sleeves without waterstop.
   3. Sleeves with waterstop.
   4. Sleeve-seal systems.
   5. Grout.
   6. Silicone sealants.
   7. Escutcheons.

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:
   1. For each type of product, excluding motors which are included in Part 1 of the fire-suppression equipment Sections.
      a. Include construction details, material descriptions, and dimensions of components.
      b. Include operating characteristics and furnished accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 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 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.

B. Motor Characteristics:
1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. 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.

C. Polyphase Motors:
1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.
   a. For motors with 2:1 speed ration, consequent pole, single winding.
   b. For motors with other than 2:1 speed ration, separate winding for each speed.
5. Multispeed Motors, Multiple Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:
    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.
11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:
1. 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.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   a. 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.
   b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:
1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

2.2 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:
1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.

B. Sleeves with Waterstop:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Advance Products & Systems, LLC.
b. CALPICO, Inc.
c. GPT; a division of EnPRO Industries.
d. Metraflex Company (The).
2. Description: Manufactured galvanized steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:
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. CALPICO, Inc.
b. GPT; a division of EnPRO Industries.
c. Metraflex Company (The).
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
a. Hydrostatic Seal: 20 psig minimum.
b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
c. Pressure Plates: Composite plastic.
d. Connecting Bolts and Nuts: Carbon steel, with ASTM B633 coating of length required to secure pressure plates to sealing elements.

D. Grout:
1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

E. Silicone Sealants:
1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.
a. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.
2. Silicone Sealant, S, P, T, NT: Single-component, 100/50, pourable, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.
a. Standard: ASTM C920, Type S, Grade P, Class 100/50, Uses T and NT.
3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.3 ESCUTCHEONS
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. Jones Stephens Corp.
2. Keeney Manufacturing Company (The).
3. Mid-America Fittings, LLC; A Midland Industries Company.
4. ProFlo; a Ferguson Enterprises, Inc. brand.
B. Escutcheon Types:
1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
2. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
3. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.
C. Floor Plates:
1. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS
A. Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.2 INSTALLATION OF SLEEVES, GENERAL
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.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with both surfaces.
a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire-resistance of floor/slab/wall.

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 that joint sealant manufacturer's literature indicates is appropriate for

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."

3.3 INSTALLATION OF SLEEVES WITH WATERSTOP

A. Install sleeve with waterstop 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 centered across width centered in concrete slab or wall.
C. Secure nailing flanges to wooden concrete forms.
D. Using grout or silicone sealant, seal space around outside of sleeves.

3.4 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Sleeve-seal systems are used in slabs-on-grade and in exterior concrete walls, for a watertight seal around service piping entries into the building and passing through exterior walls. These systems typically require installation in a sleeve for proper operation.
B. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

3.5 INSTALLATION OF ESCUTCHEONS

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.

3.6 FIELD QUALITY CONTROL

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

3.7 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Sleeves with waterstops.
   2. Exterior Concrete Walls below Grade and Concrete Slabs-on-Grade:
      a. 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 above Grade:

a. Sleeves with waterstops.
4. Interior Walls and Partitions:
a. Sleeves without waterstops.

3.8 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
5. Bare Piping in Equipment Rooms:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
B. Install floor plates for piping penetrations of equipment room floors.
C. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
1. New Piping: One piece, floor plate.

END OF SECTION 210500

SECTION 210523 - GENERAL-DUTY VALVES FOR WATER-BASED FIRE-SUPPRESSION 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. Two-piece ball valves with indicators.
   2. Iron butterfly valves with indicators.
   3. Check valves.
   4. Bronze OS&Y gate valves.
   5. Iron OS&Y gate valves.
   6. NRS gate valves.
   7. Indicator posts.
   8. Trim and drain valves.

1.3 DEFINITIONS

A. NRS: Nonrising stem.
B. OS&Y: Outside screw and yoke.
C. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, and weld ends.
   3. Set valves open to minimize exposure of functional surfaces.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:
   1. Fire Main Equipment: HAMV - Main Level.
      a. Indicator Posts, Gate Valve: HCBZ - Level 1.
      b. Ball Valves, System Control: HLUG - Level 3.
      c. Butterfly Valves: HLXS - Level 3.
      d. Check Valves: HMER - Level 3.
      e. Gate Valves: HMRZ - Level 3.
   2. Sprinkler System and Water Spray System Devices: VDGT - Main Level.
      a. Valves, Trim and Drain: VQGU - Level 1.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
   1. Automated Sprinkler Systems:
      a. Indicator posts.
      b. Valves.
         1) Gate valves.
         2) Check valves.
         3) Miscellaneous valves.

C. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B31.9 for building services piping valves.

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

E. NFPA Compliance for Valves:
   1. Comply with NFPA 13, NFPA 14, and NFPA 20.

F. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher, as required by system pressures.

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

H. Valve Actuator Types:
   1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
   2. Handwheel: For other than quarter-turn trim and drain valves.
   3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.3 TWO-PIECE BALL VALVES WITH 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. Ames Fire & Waterworks; A Watts Water Technologies Company.
   2. NIBCO INC.
   3. Victaulic Company.

B. Description:
   1. UL 1091, except with ball instead of disc and FM Global approved for indicating valves (butterfly or ball type), Class Number 1112.
   2. Minimum Pressure Rating: 175 psig.
   3. Body Design: Two piece.
   4. Body Material: Forged brass or bronze.
   5. Port Size: Full or standard.
   6. Seats: PTFE.

7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH 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. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
   2. Globe Fire Sprinkler Corporation.
   3. NIBCO INC.
   4. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
   5. Victaulic Company.

B. Description:
   1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
   2. Minimum Pressure Rating: 175 psig.
   3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
   4. Seat Material: EPDM.
   5. Stem: Stainless steel.
   6. Disc: Ductile iron, and EPDM or SBR coated.
   7. Actuator: Worm gear.
   8. Supervisory Switch: Internal or external.
   9. Body Design: Grooved-end connections.

2.5 CHECK VALVES

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. Ames Fire & Waterworks; A Watts Water Technologies Company.
   2. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
   3. FEBCO; A WATTS Brand.
   4. Globe Fire Sprinkler Corporation.
   5. Mueller Co. LLC; Mueller Water Products, Inc.
   6. NIBCO INC.
   7. Reliable Automatic Sprinkler Co., Inc. (The).

B. Description:
   1. Revising subparagraphs below requires updating the list of manufacturers above.
   2. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
   3. Minimum Pressure Rating: 175 psig.
   4. Type: Single swing check.
   5. Body Material: Cast iron, ductile iron, or bronze.
   6. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.

7. Clapper Seat: Brass, bronze, or stainless steel.
8. Hinge Shaft: Bronze or stainless steel.
9. Hinge Spring: Stainless steel.
10. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

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. Milwaukee Valve Company.
   2. NIBCO INC.
   3. United Brass Works, Inc.
   4. Zurn Industries, LLC.

B. Description:
   1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
   2. Minimum Pressure Rating: 175 psig.
   3. Body and Bonnet Material: Bronze or brass.
   4. Wedge: One-piece bronze or brass.
   5. Wedge Seat: Bronze.
   6. Stem: Bronze or brass.
   7. Packing: Non-asbestos PTFE.
   8. Supervisory Switch: External.
   9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

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. Hammond Valve.
   2. Mueller Co. LLC; Mueller Water Products, Inc.
   3. NIBCO INC.
   4. Victaulic Company.
   5. WATTS; A Watts Water Technologies Company.
   6. Zurn Industries, LLC.
   7. Kennedy Valve Company; a division of McWane, Inc.

B. Description:
   1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
   2. Minimum Pressure Rating: 175 psig.
   3. Body and Bonnet Material: Cast or ductile iron.
   4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
   5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
   6. Stem: Brass or bronze.
   7. Packing: Non-asbestos PTFE.
   8. Supervisory Switch: External.
   9. End Connections: Flanged or Grooved.

2.8 NRS GATE VALVES

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. Mueller Co. LLC; Mueller Water Products, Inc.
   2. NIBCO INC.
   3. Victaulic Company.
   4. Kennedy Valve Company; a division of McWane, Inc.

B. Description:
   1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
   2. Minimum Pressure Rating: 175 psig.
   3. Body and Bonnet Material: Cast or ductile iron.
   4. Wedge: Cast or ductile iron with elastomeric coating.
   5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
   6. Stem: Brass or bronze.
   7. Packing: Non-asbestos PTFE.
   8. Supervisory Switch: External.
   9. End Connections: Flanged or Grooved.

2.9 INDICATOR POSTS

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. American Cast Iron Pipe Company.
   2. Mueller Co. LLC; Mueller Water Products, Inc.
   3. NIBCO INC.
   4. Kennedy Valve Company; a division of McWane, Inc.

B. Description:
   1. Standard: UL 789 and FM Global standard for indicator posts.
   2. Type: Upright.
   3. Base Barrel Material: Cast or ductile iron.
   4. Extension Barrel: Cast or ductile iron.
   5. Cap: Cast or ductile iron.
   6. Operation: Handwheel.

2.10 TRIM AND DRAIN VALVES

A. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Croker; a Division of Morris Group International.
      c. Flowserve Corporation.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Potter Roemer LLC; a Division of Morris Group International.
   2. Description:
      a. Pressure Rating: 175 psig.
      b. Body Design: Two piece.

c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
b. NIBCO INC.
c. United Brass Works, Inc.
2. Description:
a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
1. 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. United Brass Works, Inc.
2. Description:
a. Pressure Rating: 175 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION, GENERAL

A. Comply with requirements in the following Sections for specific valve-installation requirements and applications:
   1. Section 211000 "Water-Based Fire-Suppression Systems" for application of valves in fire-suppression standpipes and wet-pipe, fire-suppression sprinkler systems.
B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply, except from fire-department connections. Install permanent identification signs, indicating portion of system controlled by each valve.
C. Install double-check valve assembly in each fire-protection water-supply connection.
D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
E. Install valves in horizontal piping with stem at or above the pipe center.
F. Install valves in position to allow full stem movement.
G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

END OF SECTION 210523

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE-SUPPRESSION 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. Fastener systems.
   3. Equipment supports.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
   1. 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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
   2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
   3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Cooper B-line; brand of Eaton, Electrical Sector.
      b. Empire Industries, 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.

2.4 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.5 MATERIALS

A. Aluminum: ASTM B221.
B. Carbon Steel: ASTM A1011/A1011M.
C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
D. Stainless Steel: ASTM A240/A240M.
E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

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

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

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

D. Equipment support in "Equipment Support Installation" Paragraph below requires calculating and detailing at each use.

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

F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

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

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

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.
C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for 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:
    1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
        a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon-steel pipe hangers and supports and attachments for general service applications.
F. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 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.

H. Hanger-Rod Attachments: Comply with NFPA requirements.

I. Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
   2. C-Clamps (MSS Type 23): For structural shapes.
   3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

J. Comply with NFPA requirements for applications that are not specified in piping system Sections.

K. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 210529

SECTION 210548 - VIBRATION CONTROLS FOR FIRE-SUPPRESSION 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. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Elastomeric hangers.
   5. Snubbers.
   6. Restraints - rigid type.
   7. Restraints - cable type.
   8. Restraint accessories.
   9. Post-installed concrete anchors.
   10. Concrete inserts.

1.3 DEFINITIONS

A. IBC: International Building Code.
B. OSHPD: Office of Statewide Health Planning and Development (for the State of California).
C. Non-structural building components are components or systems that are not part of the building's structural system whether inside or outside, above or below grade.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component.
   3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
   4. Annotate to indicate application of each product submitted and compliance with requirements.
B. Shop Drawings:
   1. Detail fabrication and assembly of equipment bases.
   2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
C. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building

structure, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and testing agency.
B. Welding certificates.
C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
C. Shop-Drawing Preparation:
   1. Submit design tables and information used for the design-force levels, stamped and signed by a professional structural engineer registered in the State where project is located.
D. Coordination:
   1. Coordinate trapezes or other multi-pipe hanger systems prior to submission of shop drawings for review.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Component Supports:
   1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
   2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   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. Ace Mountings Co., Inc.
      b. California Dynamics Corporation.
      c. Isolation Technology, Inc.
      d. Kinetics Noise Control, Inc.
      e. Korfund.
      f. Mason Industries, Inc.
      g. Vibration Isolation.
   2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   3. Size: Factory or field cut to match requirements of supported equipment.
   4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
   5. Surface Pattern: Smooth, ribbed, or waffle pattern.

6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:
   1. 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. Ace Mountings Co., Inc.
      b. CADDY; brand of nVent Electrical plc.
      c. California Dynamics Corporation.
      d. Kinetics Noise Control, Inc.
      e. Korfund.
      f. Mason Industries, Inc.
      g. Vibration Eliminator Co., Inc.
      h. Vibration Isolation.
   2. Mounting Plates:
      a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
      b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
   3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Ace Mountings Co., Inc.
      b. CADDY; brand of nVent Electrical plc.
      c. California Dynamics Corporation.
      d. Isolation Technology, Inc.
      e. Korfund.
      f. Mason Industries, Inc.
      g. Vibration Eliminator Co., Inc.
      h. Vibration Isolation.
   2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
      a. Housing: Cast-ductile iron or welded steel.
      b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. 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. Ace Mountings Co., Inc.
   b. CADDY; brand of nVent Electrical plc.
   c. California Dynamics Corporation.
   d. Kinetics Noise Control, Inc.
   e. Mason Industries, Inc.
   f. Vibration Isolation.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.6 SNUBBERS

A. 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. CADDY; brand of nVent Electrical plc.
   2. Kinetics Noise Control, Inc.
   3. Mason Industries, Inc.
   4. VMC GROUP.
   5. Vibration Management Corp.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
   2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
   3. Anchors in Masonry: Design in accordance with TMS 402.
   4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.7 RESTRAINTS - RIGID TYPE

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. CADDY; brand of nVent Electrical plc.
   2. California Dynamics Corporation.
   3. Cooper B-line; brand of Eaton, Electrical Sector.
   4. Hilti, Inc.
   5. TOLCO Incorporated.
   6. Unistrut; Atkore International.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or

other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. 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. CADDY; brand of nVent Electrical plc.
   2. Cooper B-line; brand of Eaton, Electrical Sector.
   3. Gripple Inc.

B. Restraint Cables: ASTM A1023/A12023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. 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. CADDY; brand of nVent Electrical plc.
   2. Cooper B-line; brand of Eaton, Electrical Sector.
   3. Hilti, Inc.
   4. Mason Industries, Inc.
   5. TOLCO Incorporated.
   6. Unistrut; Atkore International.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid restraints and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

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. Cooper B-line; brand of Eaton, Electrical Sector.
   b. Hilti, Inc.
   c. Mason Industries, Inc.
   d. Powers Fasteners.
   e. Unistrut; Atkore International.
2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Cooper B-line; brand of Eaton, Electrical Sector.
   b. Hilti, Inc.
   c. Mason Industries, Inc.
   d. Powers Fasteners.
   e. Unistrut; Atkore International.
2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.
1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.11 CONCRETE INSERTS

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. Cooper B-line; brand of Eaton, Electrical Sector.
2. Hilti, Inc.
3. Mason Industries, Inc.
4. Powers Fasteners.
5. Unistrut; Atkore International.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Hanger-Rod Stiffeners: Install where required to prevent buckling of hanger rods due to seismic forces.
B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry calculated static and seismic loads within specified loading limits.
C. Multiple Pipe Supports: Secure pipes top trapeze member with clamps approved for application by OSHPD.

3.3 INSTALLATION OF VIBRATION CONTROL DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules and/or where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.
B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
C. Installation of vibration isolators must not cause any stresses, misalignment, or change of position of equipment or piping.
D. Equipment Restraints:
    1. Install snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
    2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
E. Piping Restraints:
    1. Comply with all requirements in NFPA 13.
    2. Design piping sway bracing in accordance with NFPA 13.
        a. Maximum spacing of all sway bracing to be no greater than indicated in NFPA 13.
        b. Design loading of all sway bracing not to exceed values indicated in NFPA 13.
F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.5 FIELD QUALITY CONTROL

A. 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. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test at no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.
   6. Measure isolator restraint clearance.
   7. Measure isolator deflection.
   8. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.
D. Units will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

END OF SECTION 210548

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION 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. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.
   5. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Valve-numbering scheme.
C. Valve Schedules: Provide for fire-suppression 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. Craftmark Pipe Markers.
      d. Marking Services Inc.
      e. Seton Identification Products; a Brady Corporation company.
   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.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Brady Corporation.
   2. Carlton Industries, LP.
   3. Craftmark Pipe Markers.
   4. Marking Services Inc.
   5. Seton Identification Products; a Brady Corporation company.

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-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. 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. Brady Corporation.
   2. Carlton Industries, LP.
   3. Craftmark Pipe Markers.
   4. Marking Services Inc.
   5. 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 in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include the following:
   1. Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
   2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Brady Corporation.
   2. Carlton Industries, LP.
   3. Craftmark Pipe Markers.
   4. Marking Services Inc.
   5. Seton Identification Products; a Brady Corporation company.

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 thick, with predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass link chain 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.

2.5 WARNING TAGS

A. 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 installed.

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

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

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

A. Permanently fasten labels on each item of fire-suppression equipment.

B. Sign and Label Colors:
   1. White letters on an ANSI Z535.1 safety-red background.
C. Locate equipment labels where accessible and visible.

3.4 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 a 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 and equipment.
C. Flow- Direction Arrows: Provide arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
D. Fire-Suppression Pipe Label Color Schedule:
   1. Fire-Suppression Pipe Labels: White letters on an ANSI Z535.1 safety-red background.

3.5 INSTALLATION OF VALVE TAGS

A. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
   1. Valve-Tag Size and Shape:
      a. Fire-Suppression Standpipe: 1-1/2 inches, round.
      b. Wet-Pipe Sprinkler System: 1-1/2 inches, round.
   2. Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background.

3.6 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 required by NFPA.

END OF SECTION 210553

SECTION 211000 - WATER-BASED FIRE-SUPPRESSION 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. Fire-suppression piping, fittings, and appurtenances.
2. Fire department connections.
3. Fire-suppression piping specialties.
4. Sprinklers.
5. Alarm devices.
6. Pressure gauges.

1.3 DEFINITIONS

A. Standard-Pressure Fire-Suppression System Piping: Piping designed to operate at working pressure of 175 psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data:
1. For each type of product.
a. Include construction details, material descriptions, dimensions of individual components and profiles.
b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
1. Prepare in accordance with NFPA 13 section "Working Plans."
a. Include plans, elevations, and sections of the system piping and details.
b. Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-suppression system.
c. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Prepare computer-generated hydraulic calculations in accordance with the following:
a. Minimum operating pressure at hydraulically most remote fire hose valve is to be 100 psig.
b. Name of hydraulic program used.
c. Water supply information, including fire hydrant flow test data report.
3. Submit documents and calculations signed and sealed by qualified professional engineer responsible for their preparation
4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For fire-suppression systems indicated to comply with performance requirements and design criteria, including analysis data,

signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fire-suppression system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
B. Qualification Data: For qualified Installer and professional engineer.
C. Design Data: Approved fire-suppression piping working plans, prepared in accordance with NFPA 13, including documented approval by AHJs, and including hydraulic calculations if applicable.
D. Welding certificates.
E. Field Test Reports:
   1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
   2. Fire-hydrant flow test report.
F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-suppression systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
   2. System control valves.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by qualified professional engineer.
B. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

A. Interruption of Existing Fire-Suppression Service: Do not interrupt fire-suppression service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-suppression service in accordance with requirements indicated:

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Automatic wet-pipe sprinkler system.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-suppression System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."
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. Fire-suppression system equipment, specialties, accessories, installation, and testing to comply with NFPA 13 and ASME A17.1.
D. Standard-Pressure Piping System Component: Listed for 175 psig minimum working
E. Delegated Design: Engage a qualified professional engineer to design fire-suppression systems.
    1. Fire-Hydrant Flow Test:
        a. Perform fire-hydrant flow test and record the following conditions:
            1) Date:
            2) Time:
            3) Performed by:
            4) Location of Residual Fire Hydrant R:
            5) Location of Flow Fire Hydrant F:
            6) Static Pressure at Residual Fire Hydrant R:
            7) Measured Flow at Flow Fire Hydrant F:
            8) Residual Pressure at Residual Fire Hydrant R:
        b. Fire-hydrant flow test must be performed within previous 12 months prior to completion of design documents and hydraulic calculations.
    2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
    3. Sprinkler Occupancy Hazard Classifications:
        a. Educational: Light Hazard.
        b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
        c. Elevator Machine Room and Hoistway: Ordinary Hazard, Group 1.
        d. General Storage Areas: Ordinary Hazard, Group 1.
        e. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
        f. Offices, including Data Processing: Light Hazard.
    4. Minimum Density for Automatic-Sprinkler Piping Design:
        a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500 sq. ft. area.
        b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500 sq. ft. area.
    5. Maximum protection area per sprinkler in accordance with UL listing.
    6. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft..
b. Storage Areas: 130 sq. ft..
c. Mechanical Equipment Rooms: 130 sq. ft..
d. Electrical Equipment Rooms: 130 sq. ft..
e. Other Areas: In accordance with NFPA 13 recommendations unless otherwise indicated.

7. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:
   a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
   b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
8. Minimum residual pressure at each hose-connection outlet is as follows:
   a. NPS 2-1/2 (DN 65) Hose Connections: 100 psig.

F. Obtain documented approval of fire-suppression system design from AHJs.

2.3 FIRE-SUPPRESSION PIPING, FITTINGS, AND APPURTENANCES

A. Steel Pipe, Fittings, and Appurtenances:
1. Schedule 40 Steel Pipe: Black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
   a. Standards:
      1) UL 852.
      2) FM 1630.
   b. Factory-applied exterior coating.
   c. Factory-applied bacterial-resistant internal coating to reduce microbiologically influenced corrosion.
   d. Pipe ends may be factory or field formed to match joining method.
2. Schedule 10 Steel Pipe: Black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M.
   a. Standards:
      1) UL 852.
      2) FM 1630.
   b. Factory-applied exterior coating.
   c. Factory-applied bacterial resistant internal coating to reduce microbiologically influenced corrosion.
   d. Pipe ends may be factory or field formed to match joining method.
3. Steel Pipe Nipples: Black steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
4. Steel Couplings: Galvanized and uncoated steel, ASTM A865/A865M, threaded.
5. Gray-Iron Threaded Fittings: Galvanized and uncoated gray-iron threaded fittings, ASME B16.4, Class 125, standard pattern.
6. Malleable- or Ductile-Iron Unions: ASME B16.3.
7. Cast-Iron Flanges: ASME B16.1, Class 125.
8. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
   a. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
      1) Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
      2) Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

b. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1 carbon steel unless otherwise indicated.

9. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
   a. 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.
10. Plain-End-Pipe Fittings:
    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
       1) Gruvlok; an ASC Engineered Solution.
       2) Shurjoint; a part of Aalberts Integrated piping Systems.
       3) Victaulic Company.
    b. Pressure Rating: 175 psig minimum.
    c. Plain-End Fittings for Steel Piping: Galvanized plain-end fittings, ASTM A53/A53M, carbon steel or ASTM A106/A106M, forged steel with dimensions matching steel pipe.
    d. Plain-End-Pipe Couplings for Steel Piping: Rigid pattern for steel-pipe dimensions, ductile-iron or malleable-iron housing. Include EPDM-rubber gasket, and bolts and nuts.
11. Grooved-Joint, Steel-Pipe Appurtenances:
    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) Gruvlok; an ASC Engineered Solution.
       2) SPF/Anvil; an ASC Engineered Solution.
       3) Shurjoint; a part of Aalberts Integrated piping Systems.
       4) Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
       5) Victaulic Company.
    b. Pressure Rating: 175 psig minimum.
    c. Grooved-End Fittings for Steel Piping: Galvanized grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
    d. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.4 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connection, Flush Type:
   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. Croker; a Division of Morris Group International.
      b. Elkhart Brass Mfg. Co., Inc.
      c. Guardian Fire Equipment, Inc.
      d. Potter Roemer LLC; a Division of Morris Group International.
   2. Standard: UL 405.
   3. Description: Flush, for wall mounting.

4. Pressure Rating: 175 psig minimum.
5. Body Material: Corrosion-resistant metal, polished chrome plated cast brass.
6. Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
7. Caps: Brass, lugged type, with gasket and chain.
8. Escutcheon Plate: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: Horizontal.
11. Number of Inlets: Two.
12. Outlet Location: Bottom or Top.
13. Escutcheon Plate Marking: "AUTO SPKR".
14. Finish: Polished chrome plated.
15. Outlet Size: NPS 6.

2.5 FIRE-SUPPRESSION PIPING SPECIALTIES

A. Branch Outlet 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. Shurjoint; a part of Aalberts Integrated piping Systems.
      b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
      c. Victaulic Company.
   2. Standard: UL 213.
   3. Pressure Rating: 175 psig minimum.
   4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
   5. Type: Mechanical-tee and -cross fittings.
   6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
   7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. AGF Manufacturing, Inc.
      b. Reliable Automatic Sprinkler Co., Inc. (The).
      c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
      d. Victaulic Company.
   2. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
   3. Pressure Rating: 175 psig minimum.
   4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
   5. Size: Same as connected piping.
   6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

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. AGF Manufacturing, Inc.
   b. Croker; a Division of Morris Group International.
   c. Potter Roemer LLC; a Division of Morris Group International.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. AGF Manufacturing, Inc.
   b. Reliable Automatic Sprinkler Co., Inc. (The).
   c. Viking Group Inc.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Aegis Technologies, Inc.
2. Standard: UL 1474.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. ALEUM USA.
   b. Easyflex, Inc.
   c. Flexhead; an ASC Engineered Solution.
   d. Gateway Tubing, Inc.
   e. Victaulic Company.
2. Standards:
   a. UL 2443.
   b. FM 1637.

3. Description: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

G. Automatic (Ball-Drip) Drain Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Reliable Automatic Sprinkler Co., Inc. (The).
b. Viking Group Inc.
2. Pressure Rating: 175 psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

H. Manual Air Vent/Valve:
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. AGF Manufacturing, Inc.
2. Description: Ball valve that requires human intervention to vent air.
3. Body: Forged brass.
4. Ends: Threaded.
5. Minimize Size: 1/2 inch.
6. Minimum Water Working Pressure Rating: 300 psig.

2.6 SPRINKLERS

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. Reliable Automatic Sprinkler Co., Inc. (The).
2. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
3. Viking Group Inc.

B. Standards:
1. UL 199.
2. FM 2000.

C. Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."

D. Pressure Rating for Sprinklers:
1. Standard Automatic Sprinklers: 175 psig minimum.

E. Sprinklers, Automatic Wet with Heat-Responsive Element:
1. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
2. Standard Spray, Quick Response:
a. Upright.
b. Pendent.
c. Recessed pendent.
d. Flat, concealed pendent.
e. Vertical sidewall.

f. Horizontal sidewall.
g. Flat, concealed horizontal sidewall.

F. Sprinklers, Automatic Dry with Heat-Responsive Element:
1. Standard Spray, Quick Response:
a. Pendent.
b. Recessed pendent.
c. Horizontal sidewall.

G. Sprinkler Finishes: As selected by architect.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards and Water Shields:
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. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
c. Victaulic Company.
d. Viking Group Inc.
2. Standard: UL 199.
3. Description: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

A. Match alarm-device material and connection types to piping and equipment materials and connection types.

B. Water-Motor-Operated Alarm:
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. Reliable Automatic Sprinkler Co., Inc. (The).
b. Victaulic Company.
c. Viking Group Inc.
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 8-1/2-inch diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Water-Flow Indicators:
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. Potter Electric Signal Company, LLC.
b. System Sensor; Honeywell International, Inc.
c. Viking Group Inc.
2. Standard: UL 346.

3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches - Water-Flow Alarm Detection:
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. Potter Electric Signal Company, LLC.
   b. System Sensor; Honeywell International, Inc.
2. Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
3. Components: Two single-pole, double-throw switches with normally closed contacts.
4. Design Operation: Rising pressure to 6 psi, plus or minus 2 psi signals water flow.
5. Adjustability: Each switch is to be independently adjustable.
6. Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.

E. Valve Supervisory Switches:
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. Kennedy Valve Company; a division of McWane, Inc.
   b. Potter Electric Signal Company, LLC.
   c. System Sensor; Honeywell International, Inc.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Design: Signals that controlled valve is in other than fully open position.
5. Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
6. 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.
7. OS&Y Valve Supervisory Switches:
   a. One or two single-pole, double-throw switches.
   b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
   c. Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
   d. Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
   e. Trip Rod Length: Adjustable
8. Butterfly Valve Supervisory Switches:
   a. Two single-pole, double-throw switches.

b. NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Removable nipple.
d. Trip Rod Length: Adjustable

9. Ball Valve Supervisory Switches:
a. One single-pole, double-throw switch.
b. NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
c. Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to NPS 2.

F. Indicator-Post Supervisory Switches:
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. Potter Electric Signal Company, LLC.
b. System Sensor; Honeywell International, Inc.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.8 PRESSURE GAUGES

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. AGF Manufacturing, Inc.
2. Ametek U.S. Gauge.
3. Ashcroft Inc.
4. Brecco Corporation.
5. WIKA Instrument Corporation.

B. Standard: UL 393.
C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
D. Pressure Gauge Range: 0 to 250 psig minimum.
E. Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.
1. Flow test is to be performed to meet the criteria established by NFPA 13.
2. Flow test is to be conducted in accordance with NFPA 291.
3. Test is to be performed during a period of ordinary demand for the water system.
a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.
4. Pitot readings are to be taken at the 2-1/2-inch orifice connection.
5. The pitot reading is to range from 10 to 35 psig.

6. Open additional hydrant outlets as needed to control pitot readings.
7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.

B. Flow Test Data Written Report:
1. Flow data report is to be written in accordance with NFPA 291.
2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.

C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.

D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.

E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.2 INSTALLATION OF FIRE-SUPPRESSION PIPING

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
1. Deviations from approved working plans for piping require written approval from AHJs. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of fire-suppression piping.

C. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 and smaller.

E. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

F. Install inspector's test connections in sprinkler system piping, complete with shutoff valve, and sized and located in accordance with NFPA 13.

G. Install fire-suppression system piping with drains for complete system drainage. Extend drain piping to exterior of building where possible.

H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. Install alarm devices in piping systems.

J. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards.

K. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe/sprinkler supply. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve,

arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.

L. Fill wet-type fire-suppression system piping with water.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210500 "Common Work Results for Fire-Suppression Piping."

3.3 INSTALLATION OF PIPING JOINTS

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Pressure-Sealed Joints: Join steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

I. Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

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

3.4 INSTALLATION OF FIRE DEPARTMENT CONNECTIONS

A. Install wall-type fire department connections.
B. Install automatic (ball-drip) drain valve at each check valve for fire department connection.

3.5 INSTALLATION OF VALVES AND SPECIALTIES

A. Install listed fire-suppression system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and AHJ.
B. Install listed fire-suppression system shutoff valves in supervised open position, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.
C. Air Vent:
    1. Provide at least one air vent at high point in each wet-pipe fire-suppression system in accordance with NFPA standards. Connect vent into top of fire-suppression piping.
    2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

3.6 INSTALLATION OF SPRINKLERS

A. Install sprinklers in suspended ceilings symmetrically in center of acoustical ceiling panels within tolerance of 1/2 inch. Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.
B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.7 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment."
B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.
B. Perform the following tests and inspections:
    1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
    2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    3. Flush, test, and inspect fire-suppression systems in accordance with NFPA standards.
    4. Energize circuits to electrical equipment and devices.
    5. Coordinate with fire-alarm tests. Operate as required.
    6. Coordinate with fire-pump tests. Operate as required.

7. Verify that equipment hose threads are same as local fire department equipment.
8. Verify that sprinklers original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.

C. Fire-suppression piping system will be considered defective if it does not pass tests and inspections.

D. Fire-suppression piping system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.

E. Prepare test and inspection reports.

3.9 CLEANING

A. Clean dirt and debris from fire-suppression system piping, system control valves, sprinklers, and associated components.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain system control valves and pressure-maintenance pumps.

3.11 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

B. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2 (DN 50) and Smaller, to Be One of the Following:
1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

C. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), to Be One of the Following:
1. Schedule 10, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

D. Standard-Pressure, Wet-Pipe Sprinkler System, NPS 5 (DN 125) and Larger, to Be One of the Following:
1. Schedule 10, steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Flat concealed sprinklers.
3. Wall Mounting: Horizontal sidewall, flat concealed sidewall sprinklers as indicated.

4. Spaces Subject to Freezing: Upright sprinklers, dry pendent sprinklers, and dry sidewall sprinklers as indicated.

B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces and locations not generally exposed to view; and wax coated where exposed to acids, chemicals, or other corrosive fumes.
2. Recessed Sprinklers: Bright chrome, with factory-painted white escutcheon.
3. Flat Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

END OF SECTION 211000

SECTION 213116 - DIESEL-DRIVE, CENTRIFUGAL FIRE PUMPS

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. Split-case fire pumps.
   2. Fire-pump accessories and specialties.

B. Related Requirements:
   1. Section 262933 “Controllers for Fire-Pump Drivers” for fire pump controllers.

1.3 PERFORMANCE REQUIREMENTS

A. Retain first paragraph below with "Seismic Qualification Certificates" Paragraph in "Submittals" Article for projects requiring seismic design. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Verify requirements of authorities having jurisdiction.

B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

C. Environmental Conditions:
   1. Ambient Temperature: 60 to 100 deg F.
   2. Relative Humidity: Zero to 95 percent.
   3. Altitude: Sea level to 1000 feet.

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.

1.4 SUBMITTALS

A. Shop Drawings: For fire pumps, engine drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Include plans, elevations, sections, and mounting details.
   4. Detail fabrication and assembly of fire pumps.
   5. 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.

B. Product Certificates: For each fire pump, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

E. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

F. Delegated-Design Submittal: For fire pumps.
1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.5 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. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.6 COORDINATION
A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For fire pumps to include in emergency, operation, and maintenance manuals.

1.8 WARRANTY
A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of the fire pump and associated components that fail in materials or workmanship within manufacturer’s standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS
A. Description: Factory-assembled and -tested fire-pump and driver unit.
B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.
D. NFPA Compliance: Comply with NFPA 20.

2.2 SINGLE-STAGE, SPLIT-CASE FIRE PUMPS
A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. A-C Fire Pump Systems; a business of ITT Industries.
2. Patterson Pump Company; a subsidiary of the Gorman-Rupp Company.
3. Peerless Pump, Inc.
B. Pump:
1. Standard: UL 448, for split-case pumps for fire service.
2. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Steel shaft with bronze sleeve.
a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.

b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

D. Capacities and Characteristics:
1. Rated Capacity: 500 gpm.
2. Head: 40 psi.
3. Inlet Flange: Class 125.
4. Outlet Flange: Class 125.
5. Suction Head Available at Pump:
6. Engine Horsepower: 37 hp.
7. Engine Speed: 1770 rpm.
8. Fuel Tank Capacity: 187 gallons.
9. Rotation: Clockwise.

2.3 DIESEL ENGINE

A. Fuel: Fuel Oil.

B. Standard: UL 1247.

C. Horse Power Rating: Not less than 110 percent of maximum brake horsepower (after derating for temperature and elevation according to NFPA 20).

D. Emergency Manual Operator: Factory wired for starting and operating standby engine in case of malfunction in main controller or wiring.

E. Controls:
1. Adjustable governor.
2. Over-speed shutdown.
3. Manual reset, speed switch.
4. Instrument panel with tachometer, oil pressure gage, water temperature gage, and hour meter.

F. Fuel System:
1. Comply with NFPA 20.
2. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
3. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
4. Flexible metallic fuel lines.
5. Inline fuel filter.
6. Oil pressure safety switch.
7. Air cleaner.
8. Engine-driven oil pump.
9. Enclosed control wiring electric starter with voltage regulator.
10. Double-Wall Storage Tank: Size indicated, but not less than required by NFPA 20; with floor legs, direct-reading level gage.

G. Exhaust System:
1. Piping: ASTM A53/A53M, Type E or S, Schedule 40 black steel pipe; ASME B16.9 weld-type pipe fittings; ASME B16.5 steel flanges; and ASME B16.21 nonmetallic gaskets.
2. Fabricate double-wall, ventilated thimble from steel pipe.
3. Flexible exhaust connector.

4. Industrial exhaust silencer with spark arrestor.

H. Rated Engine Speed: 1800 rpm.

I. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

J. Engine- or Skid-Mounted Lubrication System:
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

K. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.

L. Cooling System, Factory-Mounted Radiator:
   1. Factory installed, closed loop, liquid cooled, with radiator factory mounted on fire-pump mounting frame and integral engine-driven coolant pump.
   2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   4. Expansion Tank: Constructed of welded-steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
   6. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
      a. Rating: 50-psig maximum working pressure, with coolant at 180 deg F, and noncollapsible under vacuum.
      b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

M. Muffler/Silencer, Critical Type: Sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 12 dB at 500 Hz.
   2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 87 dBA or less.

N. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

O. Starting System: 12-V dc, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: 60 seconds.

4. Battery: Adequate capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
B. Relief Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. BERMAD Control Valves.
      b. CLA-VAL Automatic Control Valves.
      c. Kunkle Valve; a part of Tyco International Ltd.
      d. OCV Control Valves.
      e. Watts Regulator Company; a division of Watts Water Technologies, Inc.
      f. Zurn Plumbing Products Group; Wilkins Water Control Products.
   2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
C. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
D. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
E. Discharge Cone: Closed type.
F. Hose Valve Manifold Assembly:
   1. Standard: Comply with requirements in NFPA 20.
   2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
   3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
   4. Automatic Drain Valve: Complying with UL 1726.
   5. Manifold:
      a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
      b. Body: Flush type, brass, with number of outlets required by NFPA 20.
      c. Escutcheon Plate: Brass or bronze; round.
      d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
      e. Exposed Parts Finish: Polished, chrome plated.
      f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.5 FUEL OIL STORAGE

A. Comply with NFPA 30.
B. Day Tank: UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
   1. Containment: Integral rupture basin, with a capacity of 150 percent of nominal capacity of day tank.

a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
2. Tank Capacity: 187 gallons.
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.
5. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

2.6 GROUT

A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink and recommended for interior and exterior applications.
C. Design Mix: 5000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
1. Verification of Performance: Rate fire pumps according to UL 448.
B. Fire pumps will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
B. Equipment Mounting:
1. Install fire pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Attach pumps to equipment base using anchor bolts.
3. Comply with requirements for vibration isolation devices specified in Section 210548 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
D. Support piping and pumps separately so weight of piping does not rest on pumps.
E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Section 211000 "Water-Based Fire-Suppression Systems"
F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in Section 211000 "Water-Based Fire-Suppression Systems."
G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
H. Install fuel system according to NFPA 20.
I. Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposal.
J. Install exhaust-system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints; install components having flanged connections with gasketed joints.
K. Install condensate-drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposal.
L. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
M. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. Align split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
C. Align piping connections.
D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211000 "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps and equipment to allow service and maintenance.
C. Connect relief-valve discharge to drainage piping or point of discharge.
D. Connect flowmeter-system meters, sensors, and valves to tubing.
E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for diesel-engine-driver fire-pump controllers specified in Section 262933 "Controllers for Fire-Pump Drivers."
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 inspect, test, and adjust components, assemblies, and equipment installations, including connections.
D. 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.
E. Tests and Inspections:
   1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
   2. Test according to NFPA 20 for acceptance and performance testing.
   3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
F. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
G. Prepare test and inspection reports.
H. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 213116

SECTION 213413 - PRESSURE-MAINTENANCE PUMPS

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. Vertical, multistage, pressure-maintenance pumps.
B. Related Requirements:
   1. Section 262933 "Controllers for Fire-Pump Drivers" for pressure-maintenance-pump controllers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
B. Shop Drawings: For pumps, accessories, and specialties.
   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. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of pressure maintenance pump and associated components that fail in materials or workmanship within manufacturer’s standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VERTICAL, MULTISTAGE, PRESSURE-MAINTENANCE 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. A-C Fire Pump; a Xylem brand.
   2. Aquarius Fluid Products, Inc.
   3. Grundfos Pumps Corporation.

4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Taco Comfort Solutions.

B. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

C. Pump Construction:
1. Barrel: Stainless steel.
2. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
3. Pump Head/Motor Mount: Cast iron.
4. Impellers: Stainless steel, balanced, and keyed to shaft.
5. Pump Shaft: Stainless steel.
6. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
7. Wear Rings: Teflon.
8. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
9. Chamber-Base Bearing: Tungsten carbide.
10. O-Rings: EPDM, NBR, or Viton.

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. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Section 210500 "Common Work Results for Fire Suppression."

F. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

G. Capacities and Characteristics:
1. Rated Capacity: 10 gpm.
2. Pressure: 50 psi.
3. Working Pressure: 175 psig minimum.
4. Discharge and Suction Flanges: Class 250.
5. Motor Horsepower: 3/4.
6. Motor Speed: 3450 rpm.
7. Electrical Characteristics:
a. Volts: 120.
b. Phases: Single.
c. Hertz: 60.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210500 "Common Work Results for Fire Suppression."
1. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Equipment Mounting:

1. Install multistage, pressure-maintenance pumps according to HI 1.4.
2. Install pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   a. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
   b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
   e. Attach pumps to equipment base using anchor bolts.
   f. Shim pumps as needed to make them level.
3. Install isolation valves in both inlet and outlet pipes near the pump. Comply with requirements for valves specified in Section 211000 "Water-Based Fire-Suppression Systems."

3.2 CONNECTIONS

A. Comply with requirements for piping and valves specified in Section 211313 "Wet-Pipe Sprinkler Systems." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to pumps and equipment to allow service and maintenance.
C. Connect jockey pumps to their controllers.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for pump marking according to NFPA 20.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Perform the following tests and inspections 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls
   3. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.
D. Test each jockey pump with its controller as a unit. Comply with requirements for controllers specified in Section 262933 “Controllers for Fire-Pump Drivers.

3.5 ADJUSTING

A. Lubricate pumps as recommended by manufacturer.

B. Set field-adjustable pressure-switch ranges as indicated.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain jockey pumps.

END OF SECTION 213413

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

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. Motors.
   2. Packless expansion joints.
   3. Grooved-joint expansion joints, lead free.
   4. Alignment guides and anchors.
   5. Sleeves without waterstop.
   6. Sleeves with waterstop.
   7. Sleeve-seal systems.
   8. Grout.
   9. Escutcheons.
   10. Thermometers, liquid in glass, lead free.
   11. Thermowells, lead free.
   12. Pressure gauges, dial type, lead free.
   13. Gauge attachments, lead free.
   14. Test plugs, lead free.
   15. Test-plug kits, lead free.
   16. Sight flow indicators, lead free.

B. Related Requirements:
   1. Section 221119 "Domestic Water Piping Specialties" for water meters.

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:
   1. For each type of product, excluding motors which are included in Part 1 of the plumbing equipment Sections.
      a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
      b. Include operating characteristics and furnished accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of expansion joint, and gauge to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.8 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

B. Contractor shall provide all fixtures, piping, valves, access doors, hangers, fittings and miscellaneous components not necessarily detailed on these drawings to render the plumbing systems complete, operable, and in accordance with applicable codes and generally accepted industry standards. The drawings are diagrammatic in nature and do not show all piping, fittings, offsets, routing, etc. Contractor shall provide all necessary components and coordinate final routing during the coordination process.

PART 2 - PRODUCTS

2.1 REFER TO SCHEDULES AND EQUIPMENT NOTES ON DRAWINGS FOR BASIS OF DESIGN MATERIALS, MANUFACTURERS AND MODEL NUMBERS.

2.2 PERFORMANCE REQUIREMENTS

A. Domestic water expansion fittings and loops for plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, 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. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.3 MOTORS

A. Motor Requirements, General:
   1. Content includes motors for use on alternating-current power systems of up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
   2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:
1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. 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.

C. Single-Phase Motors:
1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:
a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.
2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

2.4 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

A. Performance Requirements:
1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packless Expansion Joints:
1. Metal-Bellows Packless Expansion Joints, Lead Free:
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) Flex-Hose Co., Inc.
2) Flexicraft Industries.
3) Mason Industries, Inc.
4) Metraflex Company (The).
b. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
c. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
d. Type: Circular, corrugated bellows.
e. Minimum Pressure Rating: 150 psig unless otherwise indicated.
f. Configuration: Single joint class(es) unless otherwise indicated.
g. Expansion Joints for Copper Tubing: Single- or multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

1) End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint.
2) End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint or threaded.
3) End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.

C. Alignment Guides and Anchors:
1. Alignment Guides:
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) Flex-Hose Co., Inc.
2) Flex-Weld; a division of Kelco.
3) Flexicraft Industries.
4) Hyspan Precision Products, Inc.
5) Metraflex Company (The).
b. Source Limitations: Obtain alignment guides from single manufacturer.
c. Indicate alignment-guide length and maximum slider travel on Drawings.
d. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.
2. Anchor Materials:
a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Stud: Threaded, zinc-coated carbon steel.
2) Expansion Plug: Zinc-coated carbon steel.
3) Washer and Nut: Zinc-coated carbon steel.
e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: Zinc-coated carbon steel.

2.5 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:
1. Sleeves without waterstops are used for horizontal piping penetrations through interior walls or partitions. They are not intended to be used in applications where a waterstop is required.
2. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.

3. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
4. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.
5. PVC Pipe Sleeves: ASTM D1785, Schedule 40.
6. Molded-PVC Sleeves: With nailing flange.
7. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange.

B. Sleeves with Waterstop:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Advance Products & Systems, LLC.
   b. CALPICO, Inc.
   c. GPT; a division of EnPRO Industries.
   d. Metraflex Company (The).
2. Description: Manufactured galvanized-steel, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Sleeve-Seal Systems:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Advance Products & Systems, LLC.
   b. GPT; a division of EnPRO Industries.
   c. Metraflex Company (The).
2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   a. Hydrostatic Seal: 20 psig minimum.
   b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   c. Pressure Plates: Composite plastic.
   d. Connecting Bolts and Nuts: Carbon steel, with zinc coating, ASTM B633 of length required to secure pressure plates to sealing elements.

D. Grout:
1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

2.6 ESCUTCHEONS

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. Jones Stephens Corp.
2. Keeney Manufacturing Company (The).
3. Mid-America Fittings, LLC; A Midland Industries Company.
4. ProFlo; a Ferguson Enterprises, Inc. brand.

B. Escutcheon Types:

1. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
2. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
3. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

C. Floor Plates:
1. Split Floor Plates: Cast brass with concealed hinge.

2.7 METERS AND GAUGES FOR PLUMBING PIPING

A. Thermometers, Liquid in Glass, Lead Free - Plastic Case, Industrial Style:
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. Marsh Bellofram.
   b. Weiss Instruments, Inc.
   c. Weksler Glass Thermometer Corp.
   d. Winters Instruments - U.S.
2. Source Limitations: Provide liquid-in-glass, lead-free, plastic-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: Plastic; 7-inch nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F.
8. Window: Safety glass or acrylic plastic.
9. Stem: Aluminum, lead-free brass, or stainless steel and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
10. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

B. Thermowells, Lead Free:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Lead-free copper.
4. Material for Use with Steel Piping: Type 304 stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, or as required to match threaded opening in pipe.
7. Internal Threads: Size and thread type as required to match thermometer mounting threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length to extend to center of pipe.
10. Lagging Extension: Include on thermowells for insulated piping and tubing. Extension is to be of sufficient length to extend beyond finished insulation surface.

11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
12. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Pressure Gauges, Dial Type, Lead Free - Direct Mounted, Plastic Case:
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. Ashcroft Inc.
   b. Flo Fab Inc.
   c. Trerice, H. O. Co.
   d. Weiss Instruments, Inc.
   e. Weksler Glass Thermometer Corp.
   f. Winters Instruments - U.S.
2. Source Limitations: Provide dial-type, lead-free, direct-mounted, plastic-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Lead-free 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.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Safety glass or acrylic plastic.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

D. Gauge Attachments, Lead Free:
1. Snubbers: ASME B40.100, lead-free 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.
2. Valves: Lead-free brass or stainless steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

E. Test Plugs, Lead Free:
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. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. Weksler Glass Thermometer Corp.
2. Source Limitations: Provide lead-free test plugs from single manufacturer.
3. Description: Test-station fitting made for insertion into piping tee fitting.
4. Body: Lead-free brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
5. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
6. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
7. Core Inserts: EPDM self-sealing rubber.

F. Test-Plug Kits, Lead Free:
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. Blue Ribbon Corp.

b. Peterson Equipment Co., Inc.

2. Source Limitations: Provide lead-free test-plug kits from single manufacturer.
3. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
4. Low-Range Thermometer, Lead Free: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range is to be at least 25 to 125 deg F.
5. High-Range Thermometer, Lead Free: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
6. Pressure Gauge, Lead Free: Small, lead-free Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range is to be at least 0 to 200 psig.
7. Carrying Case: Metal or plastic, with formed instrument padding.

G. Sight Flow Indicators, Lead Free:
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. Dwyer Instruments, Inc.
b. Ernst Flow Industries.
c. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.
2. Source Limitations: Provide lead-free sight flow indicators from single manufacturer.
3. Description: Piping inline-installation device for visual verification of flow.
4. Construction: Lead-free bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
5. Minimum Pressure Rating: 125 psig.
6. Minimum Temperature Rating: 200 deg F.
7. End Connections: NPS 2 and smaller, threaded and NPS 2-1/2 and larger, flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
B. Indicate locations and number of guides on Drawings.
C. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest
D. Attach guides to pipe, and secure guides to building structure.

E. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
F. Anchor Attachments:
   1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
   2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.
G. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
   1. Anchor Attachment to Steel Structural Members: Attach by welding.
   2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
   3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.4 INSTALLATION OF SLEEVES - GENERAL
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.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
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 that joint sealant manufacturer's literature indicates is 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."

3.5 INSTALLATION OF SLEEVES WITH WATERSTOP
A. Install sleeve with waterstop 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 centered across width of concrete slab or wall.
C. Secure nailing flanges to wooden concrete forms.
D. Using grout, seal space around outside of sleeves. Select to maintain fire resistance of floor/slab/wall.

3.6 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.
B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. 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.

3.7 INSTALLATION OF ESCUTCHEONS

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.

3.8 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.
B. Install thermowells in vertical position in piping tees.
C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
D. Install thermowells with extension on insulated piping.
E. Fill thermowells with heat-transfer medium.
F. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
G. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.
H. Install valve and snubber in piping for each pressure gauge for fluids.
I. Install test plugs in piping tees.
J. Install thermometers in the following locations:
    1. Inlet and outlet of each water heater.
    2. Inlet and outlet of each domestic hot-water storage tank.
K. Install pressure gauges in the following locations:
    1. Building water service entrance into building.
    2. Inlet and outlet of each pressure-reducing valve.
    3. Suction and discharge of each domestic water pump.

3.9 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.10 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.
B. Adjust faces of meters and gauges to proper angle for best visibility.

3.11 FIELD QUALITY CONTROL

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

3.12 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:
    1. Exterior Concrete Walls above and below Grade:

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

2. Concrete Slabs-on-Grade:
a. Sleeves with waterstops.
1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs above Grade:
a. Sleeves with waterstops.

4. Interior Wall and Partitions:
a. Sleeves without waterstops.

3.13 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Insulated Piping:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
4. Bare Piping at Ceiling Penetrations in Finished Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms:
a. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:
1. Insulated Piping: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
3. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
5. 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.

3.14 THERMOMETER, LEAD FREE, APPLICATION

A. Thermometers at inlet and outlet of each domestic water heater are to be the following:

1. Plastic case, industrial-style, liquid-in-glass type.
2. Test plug with EPDM self-sealing rubber inserts.

B. Thermometer stems are to be of length to match thermowell insertion length.

3.15 THERMOMETER, LEAD FREE, SCALE-RANGE APPLICATION

A. Scale Range for Domestic Cold-Water Piping:
   1. 0 to 100 deg F.
B. Scale Range for Domestic Hot-Water Piping:
   1. 30 to 240 deg F.

3.16 PRESSURE-GAUGE APPLICATION

A. Pressure gauges at discharge of each water service into building are to be the following:
   1. Sealed, direct mounted, plastic case.
   2. Test plug with EPDM self-sealing rubber inserts.
B. Pressure gauges at inlet and outlet of each water pressure-reducing valve are to be the following:
   1. Sealed, direct mounted, plastic case.
   2. Test plug with EPDM self-sealing rubber inserts.
C. Pressure gauges at suction and discharge of each domestic water pump are to be the following:
   1. Sealed, direct mounted, plastic case.
   2. Test plug with EPDM self-sealing rubber inserts.

3.17 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Water Service Piping:
   1. 0 to 160 psi.
B. Scale Range for Domestic Water Piping:
   1. 0 to 100 psi.
C. Insert additional paragraphs for pressure-gauge scale ranges and applications.

3.18 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance, testing and operation of all devices including, but not limited to: all equipment items, valves, backflow preventers, filters, strainers, transmitters, sensors, meters and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.

E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

F. Cutting Holes:
   1. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to the structural engineer for review.
   2. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
   3. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Owner's Representative where working area space is limited.

G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided and coordinated.

H. Protection and Cleaning:
   1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items in the opinion of the Owner's Representative, shall be replaced at no additional cost or time to the Owner.
   2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

I. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

J. Interconnection of Electrical Instrumentation and Controls: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, alarms, instruments and computer workstations. Comply with NFPA 70.

K. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and Section 23 09 00, INSTRUMENTATION AND CONTROL FOR HVAC.

L. Work in Existing Building:
   1. Perform as specified in Division 01 – General Requirements.
   2. As specified in Division 01 – General Requirements, make alterations to existing service piping at times that will cause the least interfere with normal operation of the facility.

M. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above data equipment, and electrical and telephone switchgear.

3.19 TEMPORARY PIPING AND EQUIPMENT

A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
B. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are not allowed in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.20 RIGGING

A. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
B. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
C. Rigging plan and methods shall be referred to Owner’s Representative for evaluation prior to actual work.

3.21 PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the structural engineer.
B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 1/2 inch clearance between pipe or piping covering and adjacent work shall be provided.
D. Overhead Supports:
    1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
    2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
E. Floor Supports:
    1. Provide structural steel systems for support of equipment and piping. Structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
    2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved.
    3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.

3.22 LUBRICATION

A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
B. All devices and equipment shall be equipped with required lubrication fittings.
C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
E. All lubrication points shall be extended to one side of the equipment.

3.23 PLUMBING SYSTEMS DEMOLITION

A. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
B. The Contractor shall remove all material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from property expeditiously and shall not be allowed to accumulate.

3.24 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the facilities for beneficial use by the Owner, the facilities, equipment and systems shall be thoroughly cleaned.
B. In addition, the following special conditions apply:
    1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
    2. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint type and color obtained from manufacturer or computer matched.
    3. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.
    4. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this. Lead based paints shall not be used.

3.25 STARTUP AND TEMPORARY OPERATION

A. Startup of equipment shall be performed as described in the equipment specifications.
B. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with

design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.

D. The Commissioning Agent will observe startup and Contractor testing of selected equipment. Coordinate the startup and Contractor testing schedules with Owner's Representative and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.26 ENHANCED STARTUP AND TESTING

A. Preliminary Requirements: Provide the services of a Factory Trained Representative for the following:
   1. Inspect system installations prior to start-up.
   2. Supervise and perform initial start-up of equipment.
   3. Instruction of School District Personnel, refer to training section for additional information.

B. Plumbing System Pre-Start-Up and Start-Up:
   1. Upon completion of plumbing system installations, the Factory Trained Representative shall visit the site, inspect the installations and notify the School District's Representative of any Work which must be done or modified prior to start-up.
   2. Upon completion of required Work, or modifications to installed Work and miscellaneous testing, all as required by the particular plumbing system or apparatus, the Factory Trained Representative shall supervise the mechanical system start-up.
   3. Start-up the system and conduct a preliminary test, for the purpose of checking the general operation of the system, proving mechanical and electrical controls and making necessary adjustments.
   4. Provide pre-start-up check list, start-up list and operating instructions for the system, framed under rigid plastic and place where directed.

C. Adjustments, Preliminary Testing and Operational Testing: The following shall be performed by a Factory Trained Representative:
   1. Adjustments: Place the system in operation with automatic controls functioning. Adjust controls and apparatus for proper operation. Test all thermometers, gages and sensors for accuracy over the entire range. Remove and replace items found defective.
      i. Provide a point-to-point control check of the system to ensure that the specified inputs and outputs are receiving the signal from the proper sensors or controlling the proper device.
      ii. Set pressure controls and safety controls.
      iii. Close or de-energize all solenoids, and start-up the system.
      iv. Check that all controls and safety switches are operating properly.
   2. Preliminary Testing:
      i. Adjust the completed system and then operate it long enough to assure that it is performing properly.
      ii. Run a preliminary test for the purpose of:
         1) Determining whether the system is in a suitable condition to conduct an operational test.

2) Checking and adjusting equipment, controls, safety features, interlocks, etc.

3. Training School District personnel.
4. Operational Testing:
   i. Place system in operation, with final connections to equipment and with automatic controls operating, and operate for a minimum of 24 consecutive hours.
   ii. Operational test shall prove to the satisfaction of the School District's Representative that the system is operating as required by the drawings and the specifications. Provide notice 3 working days prior to test so arrangements can be made to have a School District Representative witness the test.
   iii. Make the following tests:
      1) Test system operational functions step by step.
      2) Test monitor and control devices.
      3) Test all remote devices such as valve and damper actuators to demonstrate full range of motion.
5. Supply all equipment necessary for system adjustment and testing.
6. Submit written report of test results signed by the Factory Trained Representative.
   1) Unforeseen Deferred Tests. If any check or test cannot be completed due to project conditions, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the School District's Representative. These tests will be conducted in the same manner as the seasonal tests as soon as possible.
   2) Seasonal Testing. Seasonal testing (tests delayed until weather conditions are closer to the system's design conditions) shall be completed as part of this contract. Make any final adjustments to the O&M manuals and as-builts resulting from information gained during testing.
   3) Perform tests as required for commissioning provisions in accordance with Section 220800, COMMISSIONING OF PLUMBING.

3.27 OPERATING AND PERFORMANCE TESTS

A. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.
B. When completion of certain work or systems occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings during the first actual seasonal use of the respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
C. Perform tests as required for commissioning provisions in accordance with Section 228000, COMMISSIONING OF PLUMBING.

3.28 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 228000, COMMISSIONING OF PLUMBING.

B Components provided under this section of the specification will be tested as part of a larger system.

3.29 OPERATION AND MAINTENANCE MANUALS

A. All new and temporary equipment and all elements of each assembly shall be included.
B. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
C. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
D. Lubrication instructions, type and quantity of lubricant shall be included.
E. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
F. Set points of all interlock devices shall be listed.
G. Trouble-shooting guide for the control system troubleshooting shall be inserted into the Operations and Maintenance Manual.
H. The control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
I. Emergency procedures for shutdown and startup of equipment and systems.

3.30 DEMONSTRATION AND TRAINING

A. The Contractor shall be responsible for coordinating, scheduling, and documenting that all required training has been completed successfully.
B. Training time shall be exclusive of all pre-start-up, start-up, testing and service call time. Duration of training shall be as required for sufficient emersion of School District personnel in the use of the equipment and systems. Unless otherwise noted in the specifications a minimum of (1) 4-hour training session shall be provided for (4) School District employees.
C. The contractor shall engage Factory Trained Representatives to perform training of School District personnel.
D. The Contractor shall have the following training responsibilities:
    1. Provide a training plan two weeks before the planned training.
    2. Provide comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.
    3. Training shall normally start with classroom sessions (virtual classroom sessions are permitted) followed by hands-on training on each piece of equipment.
    4. The training sessions shall illustrate whenever possible the use of the O&M manuals for reference.
    5. At a minimum training shall include:
        i. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
        ii. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, and any emergency procedures.
        iii. Common troubleshooting problems and solutions.
        iv. Discussion of any peculiarities of equipment installation or operation.

v. Give an overview of each system and explain each system feature in detail.
vi. Show each piece of equipment and explain its function.
vii. Demonstrate the system configuration, using one-line diagrams or other graphic techniques.
viii. Narrate the system description, explaining acronyms, technical terms, system concepts, and functions during the course of the system description narration.
ix. Thoroughly explain and demonstrate all system operation, programming, and maintenance functions. Include warnings, where applicable, to preclude incorrect system procedures.
x. Step by step instruction for programming all system functions.
xi. Procedures required for installing items which are provided as spare parts for the system.
xii. Preventive maintenance required for each piece of equipment for the system.
xiii. Refer to other specification sections for additional training requirements.

END OF SECTION 220500

SECTION 220523.12 - BALL VALVES 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. Brass ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. RPTFE: Reinforced polytetrafluoroethylene.
C. WOG: Water, oil, gas.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Brass ball valves.

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 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 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.18 for cast copper solder-joint connections.
3. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
4. ASME B16.34 for flanged and threaded end connections
5. ASME B31.9 for building services piping valves.

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

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

E. Valve Actuator Type:
1. Hand Lever: For quarter-turn valves smaller than NPS 4.

F. Valves in Insulated Piping:
1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering 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.

2.3 BRASS BALL VALVES

A. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:
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. A.Y. McDonald Mfg. Co.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Bray Commercial.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. Mueller Streamline Co.; a company of Mueller Industries.
g. Stockham; a Crane Co. brand.
h. Viega LLC.
i. WATTS; A Watts Water Technologies Company.
j. Legend Valve & Fitting, Inc.
2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

B. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Press Ends:
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. American Valve, Inc.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Crane Fluid Systems; Crane Co.

d. Hammond Valve.
e. Milwaukee Valve Company.
f. Stockham; a Crane Co. brand.
g. WATTS; A Watts Water Technologies Company.
h. Legend Valve & Fitting, Inc.
i. Viega LLC.

2. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: Buna-N or EPDM.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.
B. Provide support to piping adjacent to valves such that no force is imposed upon valves.
C. Locate valves for easy access.
D. For valves in horizontal piping, install valves with stem at or above center of pipe.
E. Install valves in position to allow full valve actuation movement.
F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.
B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 3 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:
   1. Brass ball valves, two piece with full port, and brass trim. Provide with threaded, solder or press-connection-joint ends.

END OF SECTION 220523.12

SECTION 220523.14 - CHECK VALVES 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. Bronze, swing check valves.
   2. Bronze, swing check valves, press ends.
   3. Iron, swing check valves.
   4. Iron, swing check valves with closure control.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene-diene terpolymer.
C. NBR: Nitrile butadiene rubber (also known as Buna-N).

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Bronze, swing check valves.
   2. Bronze, swing check valves, press ends.
   3. Iron, swing check valves.
   4. Iron, swing check valves with closure control.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, press connections, and weld ends.
   3. Set check valves in either closed or open position.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

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

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges for metric standard piping.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for cast-copper solder joint.
   6. ASME B16.22 for wrought copper solder joint.
   7. ASME B16.51 for press joint.
   8. ASME B31.9 for building services piping valves.

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

D. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

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

F. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE, SWING CHECK VALVES

A. Bronze, Swing Check Valves with Nonmetallic 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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Crane Fluid Systems; Crane Co.
      c. Jenkins Valves; a Crane Co. brand.
      d. Milwaukee Valve Company.
      e. NIBCO INC.
      f. Stockham; a Crane Co. brand.
   2. Standard: MSS SP-80, Type 4.
   3. CWP Rating: 200 psig.
   4. Body Design: Horizontal flow.
   5. Body Material: ASTM B62, bronze.
   6. Ends: Threaded or soldered. See valve schedule articles.
   7. Disc: PTFE.

B. Bronze, Swing Check Valves, Press Ends:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Crane Fluid Systems; Crane Co.
      c. Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.

d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
2. Standard: MSS SP-80 and MSS SP-139.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B584, bronze.
6. Ends: Press.
7. Press Ends Connection Rating: Minimum 200 psig
8. Disc: Brass or bronze.

2.4 IRON, SWING CHECK VALVES

A. Iron, Swing Check Valves with Nonmetallic-to-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. Bray Commercial.
b. Kennedy Valve Company; a division of McWane, Inc.
c. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
d. Victaulic Company.
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flange or threaded. See valve schedule articles.
7. Trim: Composition.
8. Seat Ring: Bronze.
9. Disc Holder: Bronze.
10. Disc: PTFE.
11. Gasket: Asbestos free.

2.5 IRON, SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron, Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Bray Commercial.
c. Clow Valve Company; a subsidiary of McWane, Inc.
d. Kennedy Valve Company; a division of McWane, Inc.
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flange or threaded. See valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

B. Iron, Swing Check Valves with Lever and Weight-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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Bray Commercial.
   c. Clow Valve Company; a subsidiary of McWane, Inc.
   d. Kennedy Valve Company; a division of McWane, Inc.
   e. Milwaukee Valve Company.
2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flange or threaded. See valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.
9. Closure Control: Factory-installed exterior lever and weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Examine press fittings to verify they have been properly pressed.
F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
E. Install valves in position that does not project into aisles or block access to other equipment.
F. Install valves in position to allow full stem and manual operator movement.
G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
H. Check Valves: Install check valves for proper direction of flow.
   1. Swing Check Valves: In horizontal position with hinge pin level.

I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze, swing check valves with nonmetallic disc.
      b. NPS 2-1/2 and Larger for Domestic Water: Iron, swing check valves with lever and weight or spring.
      c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron, swing check valves with lever and weight or spring.

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

C. End Connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded, soldered, or press-end connections.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flange or threaded.
   3. For Copper Tubing, NPS 5 and Larger: Flange.
   4. For Steel Piping, NPS 2 and Smaller: Threaded.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flange or threaded.
   6. For Steel Piping, NPS 5 and Larger: Flange.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze, swing check valves with nonmetallic disc, Class 125, with soldered or threaded end connections.
   2. Bronze, swing check valves with press-end connections.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron, swing check valves with nonmetallic-to-metal seats, Class 125, with threaded or flange end connections.

END OF SECTION 220523.14

SECTION 220523.15 - GATE VALVES 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. Bronze gate valves.
   2. Iron gate valves.
   3. Chainwheels.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene-diene terpolymer.
C. NRS: Nonrising stem.
D. OS&Y: Outside screw and yoke.
E. RS: Rising stem.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Bronze gate valves.
   2. Iron gate valves.
   3. Chainwheels.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, press connections, and weld ends.
   3. Set gate valves closed to prevent rattling.
B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels, stems, or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

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

B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.5 for flanges on metric standard piping.
   4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   5. ASME B16.18 for cast-copper solder joint.
   6. ASME B16.22 for wrought copper solder joint.
   7. ASME B16.51 for press joint.
   8. ASME B31.9 for building services piping valves.

C. AWWA Compliance: AWWA C606 for groove-end connections.

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

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

F. Valves in Insulated Piping: With 2-inch stem extensions.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.3 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, 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. American Valve, Inc.
      b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      c. Crane Fluid Systems; Crane Co.
      d. Milwaukee Valve Company.
      e. Stockham; a Crane Co. brand.
      f. WATTS; A Watts Water Technologies Company.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.
      c. Body Material: Bronze with integral seat and screw-in bonnet.
      d. Ends: Threaded or solder joint.
      e. Stem: Bronze.
      f. Disc: Solid wedge; bronze.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, Press Ends:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.

b. Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:
a. Standard: MSS SP-80 and MSS SP-139.
b. CWP Rating: Minimum 200 psig.
c. Body Material: Bronze with integral seat and union-ring bonnet.
d. Ends: Press.
e. Press Ends Connection Rating: Minimum 200 psig.
f. Stem: Brass or bronze, non-rising.
g. Disc: Solid wedge; bronze.
h. Packing: Graphite.
i. Port: Full.
j. Handwheel: Malleable iron, bronze, or aluminum.

2.4 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, 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. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane Fluid Systems; Crane Co.
c. Hammond Valve.
d. Kennedy Valve Company; a division of McWane, Inc.
e. Milwaukee Valve Company.
f. Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
g. WATTS; A Watts Water Technologies Company.

2. Description:
a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flange.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.5 CHAINWHEELS

A. 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. Babbitt Steam Specialty Co.
2. Roto Hammer Industries; Rotork.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve.
2. Chain: Hot-dip galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Examine press joint surfaces. Verify they are clean and free from dents and burrs, and that o-ring seals are in place and undamaged.
F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Provide support of piping adjacent to valves such that no force is imposed upon valves.
C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.
D. Install valves so that stems are horizontal or slope upward from centerline of pipe.
E. Install valves in position that does not project into aisles or block access to other equipment.
F. Install valves in position to allow full stem and manual operator movement.
G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.
H. Install chainwheels on manual operators for gate valves NPS 6 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
I. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
J. Adhere to manufacturer's installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Use gate valves for shutoff service only.
B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
C. End Connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded, soldered, or press-end connections.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flange or threaded.
   3. For Copper Tubing, NPS 5 and Larger: Flange.
   4. For Steel Piping, NPS 2 and Smaller: Threaded.
   5. For Steel Piping, NPS 2-1/2 to NPS 4: Flange or threaded.
   6. For Steel Piping, NPS 5 and Larger: Flange.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze gate valves, NRS, Class 125 with soldered or threaded ends.
   2. Bronze gate valves, press ends.
B. Pipe NPS 2-1/2 and Larger: Iron gate valves, OS&Y, Class 125 with flange ends.

END OF SECTION 220523.15

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. Trapeze pipe hangers.
   3. Thermal hanger-shield inserts.
   4. Fastener systems.
   5. Pipe stands.
   6. Equipment supports.

B. Related Requirements:
   1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Section 220500 "Common Work Results for Plumbing."

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. Trapeze pipe hangers.
   2. Pipe stands.
   3. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers and equipment supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers and equipment supports.
   2. Include design calculations for designing trapeze hangers and 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. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for 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.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

A. 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. 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 or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig 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.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   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. Hilti, Inc.
      b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      c. MKT Fastening, LLC.
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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Cooper B-line; brand of Eaton, Electrical Sector.
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
      e. MKT Fastening, LLC.
   2. Indoor Applications: Zinc-coated or stainless 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, pipe clamps, or V-shaped cradle 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 rods.

4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger depending on installation application.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads.
8. Height: Minimum 12 inches 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 rods.
4. Horizontal Member: One adjustable-height, galvanized--steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller, Clevis hanger, or Swivel hanger depending on installation application.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch, continuous-thread, galvanized-steel rod.
8. Height: Minimum 36 inches above roof.

E. High-Profile, Multiple-Pipe Stand:
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene.
3. Vertical Members: Two or more, galvanized-steel channels.
4. Horizontal Members: One or more, adjustable-height, galvanized-steel pipe support.
5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger depending on installation application.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch, continuous-thread rod.
8. Height: Minimum 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

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

2.8 MATERIALS

A. Aluminum: ASTM B221.
B. Carbon Steel: ASTM A1011/A1011M.
C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
D. Stainless Steel: ASTM A240/A240M.
E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.

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

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
    1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
    2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
    1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
    2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
D. 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. See Section 077200 "Roof Accessories" for curbs.
E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
H. Install lateral bracing with pipe hangers and supports to prevent swaying.

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

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:
   1. Attach clamps and spacers to piping.
      a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
   2. MSS SP-58, Type 39: Install 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. MSS SP-58, Type 40: Install 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 of same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

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

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

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

3.4 METAL FABRICATIONS

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

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING
A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING
A. Touchup:
   1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
      a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
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 metal trapeze pipe hangers and attachments for general service applications.
F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
G. Use padded hangers for piping that is subject to scratching.
H. Use thermal hanger-shield inserts for insulated piping and tubing.
I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.

3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION 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. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Valve tags.

1.3 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. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Brady Corporation.
      b. Carlton Industries, LP.
      c. Craftmark Pipe Markers.
      d. Marking Services Inc.
      e. Seton Identification Products; a Brady Corporation company.
   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. In "Label Content" Paragraph below, the objective of labeling equipment is to coordinate it with Drawings, including plans, details, and schedules. This will allow other information, such as capacities and operating characteristics, to be obtained.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. 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. Brady Corporation.
2. Carlton Industries, LP.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products; a Brady Corporation company.

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-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. 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. Brady Corporation.
2. Craftmark Pipe Markers.
3. Marking Services Inc.
4. 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 in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
F. 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 main distribution piping. Arrows may be either integral with label or applied separately.
   3. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 VALVE TAGS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Brady Corporation.
   2. Carlton Industries, LP.
   3. Craftmark Pipe Markers.
   4. Marking Services Inc.
   5. Seton Identification Products; a Brady Corporation company.
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 link chain 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.

PART 3 - EXECUTION

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

3.2 INSTALLATION, GENERAL REQUIREMENTS
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.
D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS
A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.
   1. White letters on an ANSI Z535.1 safety-green background.
C. Locate equipment labels where accessible and visible.

3.4 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 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 Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
E. Pipe-Label Color Schedule:
   1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
   2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
   3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
   4. Sanitary, Vent and Storm Drainage Piping: White letters on a black background.
   5. Natural Gas Piping White letters on an ANSI Z535.1 safety-green background.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
   1. Valve-Tag Size and Shape:
      a. Domestic Cold Water: 1-1/2 inches, round.
      b. Domestic Hot Water: 1-1/2 inches, round.
      c. Domestic Hot-Water Return: 1-1/2 inches, round.
      d. Natural Gas Piping: 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 in the piping system labels and background.

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 and water service piping.
   2. Domestic hot-water piping.
   3. Domestic recirculating hot-water piping.
   4. Storm-water piping.
   5. Roof drains and rainwater leaders.
   6. 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 insulation application at pipe expansion joints for each type of insulation.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties, equipment connections, and access panels.
   5. Detail application of field-applied jackets.
   6. 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. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size, as well as ASTM standard designation and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
    1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," and "Indoor Piping Insulation Schedule," articles for where insulating materials are applied.
B. Products do not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come into contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
F. Glass-Fiber, Preformed Pipe: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 850 deg F in accordance with ASTM C411. Comply with ASTM C547.
    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. Knauf Insulation.
        c. Manson Insulation Inc.

d. Owens Corning.
2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
3. Fabricated shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.3 INSULATING CEMENTS

A. Glass-Fiber and Mineral Wool 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. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
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.

C. Glass-Fiber and Mineral Wool 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.

2.4 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, 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.
c. Mon-Eco Industries, Inc.
2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
1. 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.
c. Mon-Eco Industries, Inc.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. 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. P.I.C. Plastics, Inc.
   c. Proto Corporation.
   d. Speedline Corporation.
   e. The Dow Chemical Company.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 MASTICS AND COATINGS

A. Materials are compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Vapor-Retarder Mastic, Water Based: Suitable for indoor 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.
      c. Knauf Insulation.
   2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Color: White.
C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-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.
      c. Knauf Insulation.
   2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
   3. Service Temperature Range: 0 to plus 180 deg F.
   4. Color: White.

2.6 LAGGING ADHESIVES

A. Adhesives comply with MIL-A-3316C, Class I, Grade A, and are compatible with insulation materials, jackets, and substrates.
   1. 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.
      c. Vimasco Corporation.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
4. Service Temperature Range: 20 to plus 180 deg F.
5. Color: White.

2.7 SEALANTS

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

B. Joint Sealants:
1. 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.
c. Mon-Eco Industries, Inc.
d. Owens Corning.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 58 to plus 176 deg F.
4. Color: White or gray.
5. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Materials in "FSK and Metal Jacket Flashing Sealants" Paragraph below are for sealing metal jacket seams and joints.

D. FSK and Metal 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.
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.
5. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. 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.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets 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, 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. 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.

2.10 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, 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. 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.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
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. 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.

2.11 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. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing 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.

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

C. Wire: 0.080-inch nickel-copper alloy.
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 Products.
   b. Johns Manville; a Berkshire Hathaway company.
   c. RPR Products, Inc.

2.12 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
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. McGuire Manufacturing.
b. ProFlo; a Ferguson Enterprises, Inc. brand.
c. Truebro; IPS Corporation.
d. Zurn Industries, LLC.
e. Oatey Co.

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.

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

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
D. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Definition of "wet" and its negative impacts may vary depending on type of insulation. Some types of insulation are not adversely impacted by wet conditions. Other types of insulation are very much adversely impacted.

Retaining option in first paragraph below allows the engineer/specifier, in consultation with the insulation manufacturer, to make the decision regarding when replacement of wet insulation is necessary.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
   3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
   2. Cover circumferential joints with 3-inch-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.

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.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:
   1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
   2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
   3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit.

Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

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

D. Install removable insulation covers at locations indicated. Installation conforms to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
   4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches 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 GLASS-FIBER AND MINERAL WOOL INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
   4. For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install prefabricated pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
   2. When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install prefabricated sections of same material as that of straight segments of pipe insulation when available.
   2. When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FIELD-APPLIED JACKETS

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.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal

end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "Interior Painting."
B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
C. Do not field paint aluminum jackets.

3.9 FIELD QUALITY CONTROL

A. Inspections in this article are destructive. Retain if workmanship quality is an important requirement. Architect should be prepared to reject all work if defective work is discovered in sample inspection.
B. Perform tests and inspections with the assistance of a factory-authorized service representative.
C. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Owner's Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
D. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
E. All insulation applications will be considered defective if they do not pass tests and inspections.
F. Prepare test and inspection reports.

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. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water and Water Service Piping:
    1. NPS 1-1/4 and Smaller: Insulation is the following:
        a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
    2. NPS 1-1/2 and Larger: Insulation is the following:
        a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
B. Domestic Hot and Recirculated Hot Water:
    1. NPS 1-1/4 and Smaller: Insulation is the following:

a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
2. NPS 1-1/2 and Larger: Insulation is the following:
a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 thick.

C. Horizontal Stormwater and Overflow:
1. All Pipe Sizes: Insulation is the following:
a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

D. Roof Drain and Overflow Drain Bodies:
1. All Pipe Sizes: Insulation is the following:
a. Glass-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 is the following:
a. Manufacturer’s standard Protective Shielding Guard.

F. Hot Service Drains:
1. All Pipe Sizes: Insulation is the following:
a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

G. Hot Service Vents:
1. All Pipe Sizes: Insulation is the following:
a. Glass-Fiber, Preformed Pipe Insulation, Type I: 1 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, Exposed:
1. PVC: 30 mils thick.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING OF PLUMBING

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 Cx process requirements for the following plumbing systems, assemblies, and equipment:
   1. Domestic hot-water systems and controls.
B. Related Requirements:
   1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
   2. For construction checklists, comply with requirements in various Division 22 Sections specifying plumbing systems, system components, equipment, and products.

1.3 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."
B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."
C. IAPMO: International Association of Plumbing and Mechanical Officials.
D. IgCC: International Green Construction Code.
E. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For plumbing testing technician.
B. Construction Checklists:
   1. Draft Cx plan, including draft construction checklists to be prepared by CxA under Section 019113 "General Commissioning Requirements." Contractor is to review Construction Checklist in accordance with requirements in Section 019113 "General Commissioning Requirements" and ASHRAE 202 and to resolve any issues with the CxA.

1.5 QUALITY ASSURANCE

A. Plumbing Testing Technician Qualifications: Technicians to perform plumbing Construction Checklist verification tests. Construction Checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:
   1. Journey level or equivalent skill level with knowledge of plumbing system, electrical concepts, and building operations.

2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration:
1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:
1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:
a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Plumbing system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)
PART 3 - EXECUTION

3.1 Cx PROCESS
A. Perform Cx process for plumbing systems in accordance with:
1. Commissioning standards acceptable to the authority having jurisdiction.
2. ASHRAE 202.

3.2 CONSTRUCTION CHECKLISTS
A. Preliminary detailed construction checklists are to be prepared under Section 019113 "General Commissioning Requirements" for each plumbing system, assembly, subsystem, equipment, and component required to be commissioned, as detailed in ASHRAE 202. Contractor performs the following:
1. Review plumbing preliminary construction checklists and provide written comments on Construction Checklist items where appropriate.
2. Return preliminary Construction Checklist with review comments within 10 days of receipt.
3. When review comments have been resolved, the CxA will provide final construction checklists marked "Approved for Use, (date)."
4. Use only construction checklists marked "Approved for Use, (date)." Mark construction checklists in the appropriate place, as indicated Project events are completed, and provide pertinent details and other information.

B. Systems Required to Be Commissioned:
1. Domestic hot-water systems (heaters, pumps and controls).

3.3 Cx TESTING PREPARATION

A. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating in accordance with the Contract Documents and approved submittals.
B. Certify that plumbing system instrumentation and control systems have been completed and calibrated, point-to-point checkout has been successfully completed, and systems are operating in accordance with their design sequence of operation, Contract Documents, and approved submittals. Certify that all sensors are operating within specified accuracy and that all systems are set to and maintaining set points as required by the design documents.
C. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.
    1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA, and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
    2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
    3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.
B. If tests cannot be completed because of a deficiency outside the scope of the plumbing system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.
C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO PLUMBING SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.
B. Test systems, assemblies, subsystems, equipment, and components for operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response compared to acceptance criteria.
C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.
D. Comply with Construction Checklist requirements, including material verification, installation checks, startup, and performance test requirements specified in Division 22 Sections specifying plumbing systems and equipment.
E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Cx Construction Checklist verification tests.
2. Cx Construction Checklist verification test demonstrations.

END OF SECTION 220800

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 - domestic water.
   2. Ductile-iron pipe and fittings – water service.
   3. Piping joining materials - domestic water.
   4. Transition fittings - domestic water.
   5. Dielectric fittings - domestic water.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Copper tube and fittings - domestic water.
   2. Ductile-iron pipe and fittings – water service.
   3. Piping joining materials - domestic water.
   4. Transition fittings - domestic water.
   5. Dielectric fittings - domestic water.

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 QUALITY ASSURANCE

A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.6 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 in accordance with requirements indicated:
   1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of water service.
   2. Do not interrupt water service without Construction Manager's or Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water piping, tubing, fittings, joints, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, 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.

2.2 PIPING MATERIALS

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

2.3 COPPER TUBE AND FITTINGS - DOMESTIC WATER

A. Drawn-Temper Copper Tube: ASTM B88, Type L.
B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 4.
D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 4.
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. Do not use solder joints on pipe sizes greater than NPS 4.
F. Wrought Copper Unions: ASME B16.22. Do not use solder joints on pipe sizes greater than NPS 4.
G. Pressure-Seal-Joint Fittings, Copper or Bronze - Domestic Water:
    1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
        a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
        b. Copper Press Brand; Merit Brass Company.
        c. Elkhart Brass Mfg. Co., Inc.
        d. Mueller Streamline Co.; a company of Mueller Industries.
        e. NIBCO INC.
        f. Viega LLC.
    2. Source Limitations: Obtain pressure-seal-joint fittings, copper or bronze, from single manufacturer.
    3. Housing: Copper.
    4. O-Rings and Pipe Stops: EPDM.
    5. Tools: Manufacturer's special tools.
    6. Minimum 200 psig working-pressure rating at 250 deg F.

2.4 DUCTILE-IRON PIPE AND FITTINGS - DOMESTIC WATER

A. Mechanical-Joint, Ductile-Iron Pipe:
    1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.5 PIPING JOINING MATERIALS - DOMESTIC WATER

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.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 TRANSITION FITTINGS - DOMESTIC WATER

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 Couplings - Domestic Water: AWWA C219.
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. Cascade Waterworks Mfg. Co.
b. Dresser Pipeline Solutions.
c. JCM Industries, Inc.
d. Jay R. Smith Mfg Co; a division of Morris Group International.
e. Viking Johnson.
2. Source Limitations: Obtain sleeve-type transition couplings from single manufacturer.

2.7 DIELECTRIC FITTINGS - DOMESTIC WATER

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 - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. A.Y. McDonald Mfg. Co.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. WATTS; A Watts Water Technologies Company.
d. Zurn Industries, LLC.

2. Source Limitations: Obtain dielectric unions from single manufacturer.
3. Standard: ASSE 1079.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Capitol Manufacturing Company.
b. GF Piping Systems: Georg Fischer LLC.
c. Matco-Norca.
d. WATTS; A Watts Water Technologies Company.
e. Zurn Industries, LLC.
2. Source Limitations: Obtain dielectric flanges from single manufacturer.
3. Standard: ASSE 1079.
4. Factory-fabricated, bolted, companion-flange assembly.
5. Pressure Rating: 125 psig minimum at 180 deg F.
6. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Advance Products & Systems, LLC.
b. CALPICO, Inc.
c. GPT; a division of EnPRO Industries.
2. Source Limitations: Obtain dielectric-flange insulating kits from single manufacturer.
3. Nonconducting materials for field assembly of companion flanges.
4. Pressure Rating: 150 psig.
5. Gasket: Phenolic, Temperature Rating: 225 deg F.
6. Bolt Sleeves: Phenolic or polyethylene.
7. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples - Domestic Water:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
c. Matco-Norca.
d. Sioux Chief Manufacturing Company, Inc.
e. Victaulic Company.
2. Source Limitations: Obtain dielectric nipples from single manufacturer.
3. Standard: IAPMO PS 66.
4. Electroplated steel nipple complying with ASTM F1545.
5. Pressure Rating and Temperature: 300 psig at 225 deg F.

6. End Connections: Male threaded or grooved.
7. 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. Under-building-slab, building-service piping and fire-service-main piping, NPS 4 to NPS 8 and larger is to be the following:
   1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

D. Aboveground domestic water piping, NPS 2 and smaller is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
   2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

F. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), is to be the following:
   1. Drawn-temper copper tube, ASTM B88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed 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 in accordance with CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints in accordance with AWWA C600 and AWWA M41.

D. Install valves in accordance with the following:
   1. Section 220523.12 "Ball Valves for Plumbing Piping."
   2. Section 220523.14 "Check Valves for Plumbing Piping."
   3. Section 220523.15 "Gate Valves for Plumbing Piping."

E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

F. Rough-in domestic water piping for water-meter installation in accordance with utility company's requirements.

G. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
H. 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.
I. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
J. Install piping to permit valve servicing.
K. 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.
L. Install piping free of sags and bends.
M. Install fittings for changes in direction and branch connections.
N. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
O. Install pressure gauges on suction and discharge piping for each plumbing pump. Comply with requirements for pressure gauges in Section 220500 "Common Work Results for Plumbing."
P. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123.21 "Inline, Domestic Water Pumps."
Q. Install thermometers on outlet piping from each water heater. Comply with requirements for thermometers in Section 220500 "Common Work Results for Plumbing."
R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

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 in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings in accordance with ASTM B828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
G. 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 in accordance with 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 or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, nipples.
D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

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, ductile iron tube and pipe, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
C. Support horizontal piping within 12 inches of each fitting.
D. Support vertical runs of copper tube and pipe to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 PIPING CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties. Contractor shall provide and install all necessary piping, piping offsets, fittings, etc. as required for a complete and operational system.
B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3. 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 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 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 in accordance with either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Repeat procedures if biological examination shows contamination.
      e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
   6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. 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 installation 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.

B. Piping Tests:
   a. 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.
   b. 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.
   c. 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.
   d. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
   e. Prepare reports for tests and for corrective action required.

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

D. Prepare test and inspection reports.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

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. Vacuum breakers.
   2. Backflow preventers.
   3. Water pressure-reducing valves.
   4. Balancing valves.
   5. Strainers for domestic water piping.
   6. Hose bibbs.
   7. Wall hydrants.
   8. Drain valves.
   9. Water-hammer arresters.
   10. Flexible connectors.

B. Related Requirements:
   1. Section 220500 "Common Work Results for Plumbing."
   2. Section 221116 "Domestic Water Piping".

1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.
B. AMR: Automatic Meter Reading.
C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For domestic water piping specialties.
   1. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.
B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance

with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. FEBCO; A WATTS Brand.
      c. WATTS; A Watts Water Technologies Company.
      d. Zurn Industries, LLC.
   2. Standard: ASSE 1001.
   3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
   4. Body: Bronze.
   5. Inlet and Outlet Connections: Threaded.
   6. Finish: Rough bronze.

B. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. MIFAB, Inc.
      c. WATTS; A Watts Water Technologies Company.
      d. Woodford Manufacturing Company.
      e. Zurn Industries, LLC.
      f. Jay R. Smith Mfg Co; a division of Morris Group International.
   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. Pressure Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. FEBCO; A WATTS Brand.
      c. WATTS; A Watts Water Technologies Company.
      d. Zurn Industries, LLC.
   2. Standard: ASSE 1020.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 5 psig maximum, through middle third of flow range.
   5. Size: As required.
   6. Accessories:
      a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. WATTS; A Watts Water Technologies Company.
c. Zurn Industries, LLC.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Size: NPS 3/4.
5. Accessories:
a. Valves: Ball type, on inlet and outlet.

2.4 BACKFLOW PREVENTERS
A. Double-Check, Backflow-Prevention Assemblies (P-15):
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. Ames Fire & Waterworks; A Watts Water Technologies Company.
b. FEBCO; A WATTS Brand.
c. WATTS; A Watts Water Technologies Company.
d. Zurn Industries, LLC.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Size: Refer to drawings.
6. Body: Bronze for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight-through flow.
9. Accessories:
a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
B. Backflow-Preventer Test Kits:
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. Ames Fire & Waterworks; A Watts Water Technologies Company.
b. FEBCO; A WATTS Brand.
c. WATTS; A Watts Water Technologies Company.
d. Zurn Industries, LLC.
2. Description: Factory calibrated, with gauges, fittings, hoses, and carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES
A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. WATTS; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: As required to match pipe size.
5. Design Outlet Pressure Setting: 70 psig.
6. Body: Bronze for NPS 2 and smaller; bronze for NPS 2-1/2 and NPS 3.
7. Valves for Booster Heater Water Supply: Include integral bypass.
8. End Connections: Threaded or solder for NPS 2 and smaller; flanged or solder for NPS 2-1/2 and NPS 3.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
      b. Crane Fluid Systems; Crane Co.
      c. Hammond Valve.
      d. Jenkins Valves; a Crane Co. brand.
      e. Milwaukee Valve Company.
      f. NIBCO INC.
      g. Stockham; a Crane Co. brand.
   2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
   3. Pressure Rating: 400-psig minimum CWP.
   4. Size: NPS 2 or smaller.
   5. Body: Copper alloy.
   6. Port: Standard or full port.
   7. Ball: Chrome-plated brass or stainless steel.
   8. Seats and Seals: Replaceable.
   9. End Connections: Solder joint or threaded.
   10. Handle: Vinyl-covered steel with memory-setting device.

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Keckley Company.
      b. WATTS; A Watts Water Technologies Company.
      c. Zurn Industries, LLC.
   2. Pressure Rating: 125 psig minimum unless otherwise indicated.
   3. Body: Bronze for NPS 2 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 and larger.

4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 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.
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch.
   c. Strainers NPS 5 (DN 125) and Larger: 0.10 inch.
7. Drain: Pipe plug.

2.8 HOSE BIBBS

A. Hose Bibbs (P-16):
   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. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. MIFAB, Inc.
      c. WATTS; A Watts Water Technologies Company.
      d. Woodford Manufacturing Company.
      e. Zurn Industries, LLC.
      f. Josam Company.
   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 threaded or solder-joint inlet.
   6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   7. Pressure Rating: 125 psig.
   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: Chrome or nickel plated.
   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.

2.9 WALL HYDRANTS

A. Lead Free Nonfreeze Wall Hydrants (P-7):
   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. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. MIFAB, Inc.
      c. WATTS; A Watts Water Technologies Company.
      d. Woodford Manufacturing Company.
      e. Zurn Industries, LLC.
      f. Josam Company.
   2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
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: Rough bronze.
10. Nozzle and Wall-Plate Finish: Rough bronze.
11. Operating Keys(s): One with each wall hydrant.

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 minimum CWP.
   3. Size: NPS 3/4.
   4. Body: Copper alloy.
   5. Ball: Chrome-plated brass.
   6. Seats and Seals: Replaceable.
   7. Handle: Vinyl-covered steel.
   8. Inlet: Threaded or solder joint.
   9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.11 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:
   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. AMTROL, Inc.
      b. Jay R. Smith Mfg Co; a division of Morris Group International.
      c. MIFAB, Inc.
      d. Sioux Chief Manufacturing Company, Inc.
      e. WATTS; A Watts Water Technologies Company.
      f. Zurn Industries, LLC.
      g. Josam Company.
   2. Standard: ASSE 1010 or PDI-WH 201.
   3. Type: Metal bellows, Piston, or Diaphragm.
   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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Flex-Hose Co., Inc.
   2. Mason Industries, Inc.
   3. Metraflex Company (The).

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: Minimum 200 psig.
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
C. 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.
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
   3. Do not install bypass piping around backflow preventers.
B. Water Regulators: Install with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.
C. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.
D. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve and pump.
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. Contractor shall provide and install all necessary piping, piping offsets, fittings, etc. as required for a complete and operational system.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.
B. Set field-adjustable flow set points of balancing valves.

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

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
   1. Test each reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 221119

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

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. In-line, sealless centrifugal pumps.

1.3 ACTION SUBMITTALS

A. Product Data Submittals: For each product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 220800, COMMISSIONING OF PLUMBING SYSTEMS.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which pumps will be attached.
   2. Size and location of initial access modules for acoustical tile.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of in-line domestic-water pump and associated components that fail in materials or workmanship within manufacturer’s standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: UL 778 for motor-operated water pumps.
C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS (P-14)

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. Flo Fab Inc.
   2. Grundfos Pumps Corporation.
   3. Taco Comfort Solutions.
B. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.
C. Capacities and Characteristics:
   1. Refer to schedule on drawings.
D. Pump Construction:
   1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
   2. Minimum Working Pressure: 125 psig.
   3. Maximum Continuous Operating Temperature: 220 deg F.
   4. Casing: Bronze, with threaded or companion-flange connections.
   5. Impeller: Plastic, composite or stainless steel.
   6. Motor: Single speed.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."
   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.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   1. Type: Water-immersion temperature sensor, for installation in piping.
   2. Range: 50 to 125 deg F.
   3. Enclosure: NEMA 250, Type 4X.
   4. Operation of Pump: On or off.
   5. Transformer: Provide if required.
   6. Power Requirement: 120 V ac.
   7. Settings: Start pump at 105 deg F and stop pump at 120 deg F.
B. Timers: Electric, for control of hot-water circulation pump.
   1. Type: Programmable, seven-day clock with manual override on-off switch.
   2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.

3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 INSTALLATION OF PUMPS

A. Mount pumps in orientation complying with manufacturer's written instructions.
B. Pump Mounting:
   1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   3. Install anchor bolts to elevations required for proper attachment to supported equipment.
C. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.
   1. Comply with requirements for hangers and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
D. Install thermostats in hot-water return piping.
E. Install timers on wall in mechanical room.
F. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.
C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:
   1. Section 220523.12 "Ball Valves for Plumbing Piping."
   2. Section 220523.14 "Check Valves for Plumbing Piping."
   3. Section 220523.15 "Gate Valves for Plumbing Piping."
   4. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping

around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220500 "Common Work Results for Plumbing."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring between temperature controllers and devices.
C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.
B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.
   4. Set thermostats and timers, for automatic starting and stopping operation of pumps.
   5. Perform the following startup checks for each pump before starting:
      a. Verify bearing lubrication.
      b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
      c. Verify that pump is rotating in the correct direction.
   6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   7. Start motor.
   8. Open discharge valve slowly.
   9. Adjust temperature settings on thermostats.
   10. Adjust timer settings.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR

and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain in-line, domestic water pumps and associated controls.

3.9 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 220800, COMMISSIONING OF PLUMBING SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

3.10 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust initial temperature set points.
C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

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. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hubless, cast-iron soil pipe and fittings.
   3. Specialty pipe fittings.

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Field quality-control reports.

1.5 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 in accordance with requirements indicated:
   1. Notify Construction Manager and Owner no fewer than five 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 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 are capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10 ft. head of water.

2.2 PIPING MATERIALS

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

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

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

A. 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. 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:
   1. Marked with CISPI collective trademark.
   2. ASTM A74, service and extra-heavy cast iron.

C. Gaskets: ASTM C564, rubber.

D. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. 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:
   1. Marked with CISPI collective trademark.
   2. ASTM A888 or CISPI 301.

C. Heavy-Duty, Hubless-Piping Couplings:
   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. AB & I Foundry; a part of the McWane family of companies.
      b. Charlotte Pipe and Foundry Company.
      c. MIFAB, Inc.
      d. Tyler Pipe; a subsidiary of McWane Inc.
   2. Standards: ASTM C1277 and ASTM C1540..
   3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. 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 C1460.
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.

4. Pressure 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) Apollo Valves; a part of Aalberts Integrated Piping Systems.
      2) Cascade Waterworks Mfg. Co.
      3) EBAA Iron Sales, 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. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with
   2. Dielectric Unions:
      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) A.Y. McDonald Mfg. Co.
         2) HART Industrial Unions, LLC.
         3) Jomar Valve.
         4) WATTS; A Watts Water Technologies Company.
         5) Wilkins.
         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.
   3. Dielectric Flanges:
      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) Capitol Manufacturing Company.
         2) GF Piping Systems: Georg Fischer LLC.
         3) Matco-Norca.
         4) WATTS; A Watts Water Technologies Company.
         5) Zurn Industries, LLC.

b. Description:
1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.
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.

4. Dielectric-Flange Insulating Kits:
a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1) Advance Products & Systems, LLC.
2) CALPICO, Inc.
3) GF Piping Systems: Georg Fischer LLC.
4) 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.
5. Dielectric Nipples:
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) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
2) Elster Perfection; Honeywell.
3) Matco-Norca.
4) Precision Plumbing Products.
5) Victaulic Company.
b. Description:
1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING
A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING
A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
   1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
   2. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
      a. Straight tees, elbows, and crosses may be used on vent lines.
   3. Do not change direction of flow more than 90 degrees.
   4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
      a. Reducing size of waste piping in direction of flow is prohibited.

K. 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. Horizontal Sanitary Waste Piping: Two percent downward in direction of flow for piping NPS 2-1/2 or smaller: one percent downward in direction of flow for piping NPS 3 and larger.
   2. Vent Piping: One percent down toward vertical fixture vent or toward vent stack.

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

N. Plumbing Specialties:
   1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
      a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
      b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
   2. Install drains in sanitary waste gravity-flow piping.
      a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
P. Install sleeves for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
   1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
R. Install escutcheons for piping penetrations of walls, ceilings, and floors.
   1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
C. Hubless, Cast-Iron Soil Piping Coupled Joints:
   1. Join hubless, cast-iron soil piping in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
D. Joint Restraints and Sway Bracing:
   1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
      a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
      b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
      c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

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.
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 or unions.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, 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 specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment".

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42 clamps.
4. Install individual, straight, horizontal piping runs:
   a. 100 Ft. and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Ft.: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Ft. if Indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Ft. or Longer: MSS Type 44 pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52 spring hangers.

B. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
D. Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Contractor shall provide and install all necessary piping, piping offsets, fittings, etc. as required for a complete and operational system.
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. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.
B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 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 in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
   a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
   a. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
   a. Close openings in piping system and fill with water to point of overflow, but not less than 10 ft. head of water.
   b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
   c. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.
   a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1 inch wg.
   b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
   c. Air pressure must remain constant without introducing additional air throughout period of inspection.
   d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

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. 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 NPS 4 and smaller are to be the following:
   1. Service cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger are to be the following:
   1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller is to be the following:
   1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger is to be the following:
   1. Service cast iron, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller are to be the following:
   1. Extra-heavy cast-iron soil piping; gaskets; and gasketed joints.
   2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Underground, soil and waste piping NPS 5 and larger are to be the following:
   1. Extra-heavy, cast-iron soil piping; gaskets; and gasketed joints.
   2. PVC piping in first subparagraph below is limited to NPS 12.
   3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

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. Cleanouts.
   2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:
   1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 DEFINITIONS

A. ABS: Acrylonitrile butadiene styrene.

B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

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

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

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:
   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. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. Tyler Pipe; a subsidiary of McWane Inc.
      e. WATTS; A Watts Water Technologies Company.

f. 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 or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. WATTS; A Watts Water Technologies Company.
f. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Inside calk or Spigot.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy Polished bronze.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Light 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. WATTS; A Watts Water Technologies Company.
e. 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 or raised head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:
1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2: 4-inch-minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Inline Trap Seal:
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. Green Drain, Inc.
   b. Jay R. Smith Mfg Co; a division of Morris Group International.
   c. Josam Company.
   d. MIFAB, Inc.
   e. RectorSeal Plumbing; A CSW Industrials Company.
   f. 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.

D. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. 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.
G. Vent Caps:
   1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
   2. Size: Same as connected stack vent or vent stack.
H. Frost-Resistant Vent Terminals Insert drawing designation, if any:
   1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
   2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
I. Expansion Joints:
   1. Standard: ASME A112.6.4.
   2. Body: Cast iron with bronze sleeve, packing, and gland.
   3. End Connections: Matching connected piping.
   4. Size: Same as connected soil, waste, or vent piping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.
B. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
C. Assemble open drain fittings and install with top of hub 2 inches above floor.
D. Install deep-seal traps on floor drains and other waste outlets, if indicated.
E. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
F. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
G. Install vent caps on each vent pipe passing through roof.
H. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
I. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
J. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
K. Install wood-blocking reinforcement for wall-mounting-type specialties.
L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 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.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene styrene.
B. FRP: Fiberglass-reinforced plastic.
C. HDPE: High-density polyethylene.
D. PE: Polyethylene.
E. PP: Polypropylene.
F. PVC: Polyvinyl chloride.

1.4 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 (P-8):
   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. Jay R. Smith Mfg Co; a division of Morris Group International.
      b. Josam Company.
      c. MIFAB, Inc.
      d. WATTS; A Watts Water Technologies Company.
      e. Wade; a subsidiary of McWane Inc.
      f. Zurn Industries, LLC.
   2. Standard: ASME A112.6.3.
   3. Pattern: Floor drain.
   4. Body Material: Cast iron.
   5. Seepage Flange: Not required.
   6. Anchor Flange: Required.
   7. Clamping Device: Required.
   8. Outlet: Bottom.
   9. Backwater Valve: Not required.

10. Coating on Interior and Exposed Exterior Surfaces: Not required.
11. Sediment Bucket: Required where indicated in schedule.
12. Top or Strainer Material: Bronze or Nickel bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Square.
15. Dimensions of Top or Strainer: Refer to schedule on drawings.
16. Top Loading Classification: Light Duty.
17. Funnel: Not required.
18. Inlet Fitting: Not required.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   3. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
      b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
      c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
      a. Maintain integrity of waterproof membranes where penetrated.
   5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
B. Install trench drains at low points of surface areas to be drained.
   1. Set grates of drains flush with finished surface, unless otherwise indicated.

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 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 221414 - STORM DRAINAGE 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. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Hub-and-spigot, cast-iron soil pipe and fittings.
   2. Hubless, cast-iron soil pipe and fittings.
   3. Specialty pipe fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and elevations, or Building Information Model (BIM) drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Provide materials bearing label, stamp, or other markings of specified testing agency.

1.6 FIELD CONDITIONS

A. Interruption of Existing Storm Drainage 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 and Owner no fewer than five days in advance of proposed interruption of storm drainage service.
   2. Do not proceed with interruption of storm drainage service without Construction Manager's or Owner's written permission.

1.7 WARRANTY

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation are to be capable of withstanding the following minimum working pressure unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.

2.2 PIPING MATERIALS

A. Piping materials to bear label, stamp, or other markings of specified testing agency.
B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

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

A. 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. 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:
   1. Marked with CISPI collective trademark and NSF certification mark.
   2. Standard: ASTM A74.
   3. Class: Service weight and Extra heavy cast iron.
C. Gaskets: ASTM C564, rubber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. 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:
   1. Marked with CISPI collective trademark and NSF certification mark.
   2. Standards: ASTM A888 and CISPI 301.
C. Heavy-Duty, Hubless-Piping Couplings:
   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. ANACO-Husky.
      b. Charlotte Pipe and Foundry Company.
      c. Fernco Inc.
      d. MIFAB, Inc.
   2. Standard: ASTM C1277 or ASTM C1540.
   3. Description: Stainless steel shield with stainless steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
   3. 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) Dallas Specialty & Mfg. Co.
         2) Fernco Inc.
         3) Mission Rubber Company, LLC; a division of MCP Industries.
      b. Standard: ASTM C1460.
      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.
   4. Pressure 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) EBAA Iron Sales, Inc.
         3) JCM Industries, Inc.
      b. Standard: AWWA C219.
      c. Description: Metal, sleeve-type couplings same size as pipes to be joined, and with pressure rating at least equal to and ends compatible with pipes to be joined.
      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. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
   2. Dielectric Unions:
      a. 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) A.Y. McDonald Mfg. Co.
         2) HART Industrial Unions, LLC.
         3) Jomar Valve.
         4) WATTS; A Watts Water Technologies Company.
         5) Zurn Industries, LLC.
      b. Description:
         1) Standard: ASSE 1079.
         2) Pressure Rating: 150 psig minimum at 180 deg F.

3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:
   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; A Watts Water Technologies Company.
   b. Description:
      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig minimum at 180 deg F.
      4) End Connections: Solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      1) Advance Products & Systems, LLC.
      2) GPT; a division of EnPRO Industries.
   b. Description:
      1) Pressure Rating: 150 psig.
      2) Gasket: Neoprene or phenolic.
      3) Bolt Sleeves: Phenolic or polyethylene.
      4) Washers: Phenolic with steel-backing washers.
5. Dielectric Nipples:
   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) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
      2) Matco-Norca.
      3) Precision Plumbing Products.
   b. Description: Electroplated steel nipple.
   c. Standards: ASTM F492, ASME B1.20.1.
   d. Pressure Rating: 300 psig at 225 deg F.
   e. End Connections: Male threaded or grooved.
   f. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
B. Install piping as indicated unless deviations from layout are approved on coordination drawings.
C. Install piping in concealed locations.
   1. Piping installed in equipment rooms, service areas, and where indicated may be exposed.

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.
E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
F. Install piping to permit valve servicing.
G. Install piping at indicated slopes.
H. Install piping free of sags and bends.
I. Install fittings for changes in direction and branch connections.
J. Install piping to allow application of insulation.
K. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
    1. Do not change direction of flow more than 90 degrees.
    2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
        a. Reducing size of drainage piping in direction of flow is prohibited.
L. Lay buried building piping beginning at low point of each system.
    1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
    2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
    3. Maintain swab in piping and pull past each joint as completed.
M. Install piping at the following minimum slopes unless otherwise indicated.
    1. Horizontal Storm Drain: 1/4 inch per foot downward in direction of flow for piping NPS 2-1/2 and smaller; 1/8 inch per foot downward in direction of flow for piping NPS 3 and larger.
N. Install cast-iron soil piping in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Ch IV, "Installation of Cast Iron Soil Pipe and Fittings."
    1. Install encasement on underground piping in accordance with ASTM A674 or AWWA C105/A 21.5.
O. Plumbing Specialties:
    1. Install cleanouts in storm drainage gravity-flow piping in accessible locations.
        a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
        b. Comply with requirements for cleanouts specified in Section 221423 "Storm Drainage Piping Specialties."
    2. Install drains in storm drainage gravity-flow piping.
        a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."
P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
Q. Install sleeves for piping penetrations of walls, ceilings, and floors.
    1. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
R. Install sleeve seals for piping penetrations of concrete walls and slabs.
    1. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."
S. Install escutcheons for piping penetrations of walls, ceilings, and floors.
    1. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
B. Hub-and-Spigot, Cast-Iron Soil Piping Caulked Joints: Join in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum caulked joints.
C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join in accordance with CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
D. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1.
    1. Cut threads full and clean using sharp dies.
    2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
        a. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
        b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
        c. Do not use pipe sections that have cracked or open welds.
E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
F. Joint Restraints and Sway Bracing:
    1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
        a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
        b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
        c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.4 INSTALLATION OF SPECIALTY PIPE FITTINGS

A. Transition Couplings:
    1. Install transition couplings at joints of piping with small differences in ODs.
    2. In Drainage Piping: Shielded, nonpressure transition couplings.
B. Dielectric Fittings:
    1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
    2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
    3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
    4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF VALVES.

A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."
3. Section 220523.15 "Gate Valves for Plumbing Piping."

B. Shutoff Valves:
1. Install shutoff valve on each sump pump discharge.
2. Install gate or full port ball valve for piping NS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Backwater Valves: Install backwater valves in piping subject to backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. 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.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

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

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

D. Support vertical cast-iron and galvanized steel tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Contractor shall provide and install all necessary piping, piping offsets, fittings, etc. as required for a complete and operational system

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.
1. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor.

3. Comply with requirements for backwater valves, cleanouts and drains specified in Section 221423 "Storm Drainage Piping Specialties."

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

E. Make connections in accordance with the following unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. 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 storm drainage piping in accordance with procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved.
a. Expose work that was covered or concealed before it was tested.
3. Test Procedure:
a. Test storm drainage piping on completion of roughing-in.
b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
c. From 15 minutes before inspection starts until completion of inspection, water level must not drop.
d. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

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

3.11 PROTECTION

A. Protect piping and drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
B. Place plugs in ends of uncompleted piping at end of day and when work stops.
C. Repair damage to adjacent materials caused by storm drainage piping installation.

3.12 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
B. Aboveground storm drainage piping NPS 6 and smaller is to be any of the following:
    1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
    2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
    3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
C. Aboveground, storm drainage piping NPS 8 and larger is to be any of the following:
    1. Service weight, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
    2. Hubless, cast-iron soil pipe and fittings; heavy-duty, hubless-piping couplings; and coupled joints.
    3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
D. Underground storm drainage piping NPS 6 and smaller shall be the following:
    1. Extra heavy, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
    2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
E. Underground, storm drainage piping NPS 8 and larger is to be the following:
    1. Extra heavy, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
    2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION 221414

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

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. General-purpose roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Backwater valves.

B. Related Requirements:
   1. Section 076200 “Sheet Metal Flashing and Trim” for penetrations of roofs.
   2. Sectopm 078413 “Penetration Firestopping” for firestopping roof penetrations..

1.3 ACTION SUBMITTALS

A. Product Data:
   1. General-purpose roof drains.
   2. Miscellaneous storm drainage piping specialties.
   3. Cleanouts.
   4. Backwater valves.

1.4 QUALITY ASSURANCE

A. Provide drainage piping specialties are to bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 GENERAL-PURPOSE ROOF DRAINS

A. Cast-Iron Roof Drains:

1. Cast-Iron, Large-Sump, General-Purpose Roof Drains (P-9 and P-11):
   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) Jay R. Smith Mfg Co; a division of Morris Group International.
      2) Josam Company.
      3) MIFAB, Inc.
      4) WATTS; A Watts Water Technologies Company.
      5) Wade; a subsidiary of McWane Inc.
      6) Zurn Industries, LLC.
   b. Standard: ASME A112.6.4.
   c. Body Material: Cast iron.
   d. Dimension of Body: Nominal 14-to 16-inch diameter.
   e. Dome Material: PE.

f. Combination flashing ring and gravel stop.
g. Outlet: Bottom.
h. Outlet Type: No-hub.
i. Options:
1) Extension collars.
2) Underdeck clamp.
3) Sump receiver plate.
4) Vandal-proof dome.
5) Water Dam: 2 inches high on overflow drains.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles (P-10):
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. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
3. Size: Same as connected downspout.
4. Material: Type 304 stainless steel.
5. Piping Connection Type: No-hub or slip on.

2.3 CLEANOUTS

A. Cast-Iron Cleanouts:
1. Cast-Iron Exposed Cleanouts:
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) Jay R. Smith Mfg Co; a division of Morris Group International.
2) MIFAB, Inc.
3) WATTS; A Watts Water Technologies Company.
4) Wade; a subsidiary of McWane Inc.
5) Josam Company.
b. Standard: ASME A112.36.2M.
c. Size: Same as connected branch.
d. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or No-hub, cast-iron soil pipe test tee as required to match connected piping.
e. Closure: Countersunk or raised-head, brass plug.
f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
2. Cast-Iron Exposed Floor Cleanouts:
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) Jay R. Smith Mfg Co; a division of Morris Group International.
2) Sioux Chief Manufacturing Company, Inc.
3) WATTS; A Watts Water Technologies Company.
4) Wade; a subsidiary of McWane Inc.
5) Zurn Industries, LLC.

b. Standard: ASME A112.36.2M.
c. Size: Same as connected branch.
d. Type: Heavy-duty, adjustable housing.
e. Body or Ferrule: Cast iron.
f. Outlet Connection: No-hub or Hub with gasket.
g. Closure: Brass plug with tapered threads.
h. Adjustable Housing Material: Cast iron with threads.
i. Frame and Cover Material and Finish: Nickel-bronze, copper alloy Polished bronze.
j. Frame and Cover Shape: Round.
k. Top Loading Classification: Light Duty.
l. Riser: ASTM A74, Extra-Heavy Class, cast-iron drainage pipe fitting and riser to cleanout.
m. Options:
    1) Clamping device.

3. Cast-Iron Wall Cleanouts:
    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) Jay R. Smith Mfg Co; a division of Morris Group International.
        2) MIFAB, Inc.
        3) WATTS; A Watts Water Technologies Company.
        4) Wade; a subsidiary of McWane Inc.
        5) Zurn Industries, LLC.
        6) Josam Company.
    b. Standard: ASME A112.36.2M. Include wall access.
    c. Size: Same as connected drainage piping.
    d. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
    e. Closure Plug:
        1) Material: Brass.
        2) Head: Countersunk or raised.
        3) Drilled and threaded for cover attachment screw.
        4) Size: Same as, or not more than, one size smaller than cleanout size.
    f. Wall-Access Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
    g. Wall-Access Frame and Cover: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
4. Cast-Iron Test Tees:
    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) Jay R. Smith Mfg Co; a division of Morris Group International.
        2) MIFAB, Inc.
        3) Tyler Pipe; a subsidiary of McWane Inc.
        4) WATTS; A Watts Water Technologies Company.
        5) Zurn Industries, LLC.
        6) Josam Company.
    b. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
    c. Size: Same as connected drainage piping.

d. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
e. Closure Plug: Countersunk or raised head, brass.
f. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

2.4 BACKWATER VALVES

A. Cast-Iron Backwater Valves:
1. Cast-Iron, Horizontal Backwater Valves:
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) Jay R. Smith Mfg Co; a division of Morris Group International.
2) MIFAB, Inc.
3) WATTS; A Watts Water Technologies Company.
4) Wade; a subsidiary of McWane Inc.
5) Zurn Industries, LLC.
6) Josam Company.
b. Standard: ASME A112.14.1.
c. Size: Same as connected piping.
d. Body Material: Cast iron.
e. Cover: Cast iron with bolted or threaded to access check valve.
f. End Connections: Hub and spigot or no-hub.
g. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
h. Extension: ASTM A74, Service Class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains in accordance with roof membrane manufacturer's written installation instructions at low points of roof areas.
1. Install flashing collar or flange of roof drain to maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.
B. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
C. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 ft. for piping NPS 4 and smaller and 100 ft. for larger piping.
4. Locate cleanouts at base of each vertical storm piping conductor.
D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
F. Install horizontal backwater valves in floor with cover flush with floor.
G. Install test tees in vertical conductors and near floor.
H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
I. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
    1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 CONNECTIONS
A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 INSTALLATION OF FLASHING
A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.

3.4 CLEANING
A. Clean piping specialties during installation and remove dirt and debris as work progresses.

3.5 PROTECTION
A. Protect piping specialties during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic and construction work.
B. Place plugs in ends of uncompleted piping at end of each day and when work stops.

END OF SECTION 221423

SECTION 223300 - ELECTRIC, DOMESTIC-WATER 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:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Commercial, electric, storage, domestic-water heaters.
   2. Domestic-water heater accessories.

B. Product Data Submittals: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:
   1. Include diagrams for power, signal, and control wiring.

D. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 220800, COMMISSIONING OF PLUMBING SYSTEMS.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Product Certificates: For each type of commercial and tankless, electric, domestic-water heater.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including storage tank and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Periods: From date of Substantial Completion.
      a. Commercial, Electric, Storage, Domestic-Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: Three years.
      b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters (P-12):
   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. A. O. Smith Corporation.
      b. American Water Heaters.
      c. Bradford White Corporation.
      d. Rheem Manufacturing Company.
      e. State Industries.
   2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
   3. Standard: UL 1453.
   4. Storage-Tank Construction: ASME-code, steel vertical arrangement.
      a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.
         1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
         2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.
      b. Pressure Rating: 150 psig.

c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Drain Valve: Corrosion-resistant metal with hose-end connection.
   c. Insulation: Comply with ASHRAE/IES 90.1.
   d. Jacket: Steel with enameled finish or high-impact composite material.
   e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
   f.Temperature Control: Adjustable thermostat.
   g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
   h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.
6. Special Requirements: NSF 5 construction.

B. Capacity and Characteristics:
   1. Refer to schedule on drawings.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks (P-13):
   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. AMTROL, Inc.
      b. Taco Comfort Solutions.
   2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
   3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   4. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.
   5. Capacity and Characteristics:
      a. Refer to schedule on drawings.

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE/IES 90.1.

E. Manifold Kits: Domestic-water-heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and memory-stop balancing valves to provide balanced flow through each domestic-water heater.
   1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
   2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
F. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.
G. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
H. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than working-pressure rating of domestic-water heater.
I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
J. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."
   1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
   2. Maintain manufacturer's recommended clearances.
   3. Arrange units so controls and devices that require servicing are accessible.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install thermometers on inlet and outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

I. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."

J. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

K. Fill electric, domestic-water heaters with water.

L. Charge domestic-water expansion tanks with air to required system pressure.
M. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water to contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS
A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION
A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform tests and inspections with the assistance of a factory-authorized service representative.
B. Tests and Inspections:
1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.5 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.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial and tankless, electric, domestic-water heaters. Training to be a minimum of four hour(s).

3.7 COMMISSIONING
A. Provide commissioning documentation in accordance with the requirements of Section 220800, COMMISSIONING OF PLUMBING SYSTEMS.

B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 223300

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
   1. Faucets for lavatories and sinks.
   2. Flushometers.
   3. Toilet seats.
   4. Protective shielding guards.
   5. Fixture supports.
   6. Water closets.
   7. Urinals.
   8. Lavatories.
   9. Service basins.

B. Related Sections include the following:
   1. Division 22 Section, "Domestic Water Piping Specialties" for specialty fixtures not included in this Section.
   2. Division 22 Section, "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   3. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   4. Vitreous-China Fixtures: ASME A112.19.2M.
   5. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
   6. Water-Closet, Flushometer Tank Trim: ASSE 1037.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
   1. Faucets: ASME A112.18.1.
   2. Hose-Connection Vacuum Breakers: ASSE 1011.
   3. Hose-Coupling Threads: ASME B1.20.7.
   4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   5. NSF Potable-Water Materials: NSF 61.
   6. Pipe Threads: ASME B1.20.1.
   7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   8. Supply Fittings: ASME A112.18.1.
   9. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Manual-Operation Flushometers: ASSE 1037.
   4. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Flexible Water Connectors: ASME A112.18.6.
   2. Floor Drains: ASME A112.6.3.

3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls, blowers, pumps, heaters, and timers.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period for Commercial Applications: One year(s) from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
   3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than 12 of each type.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets (P-3 and P-4):
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Bradley Corporation.
      b. Chicago Faucets.
      c. Delta Faucet Company.
      d. Speakman Company.
      e. Zurn Plumbing Products Group; Commercial Brass Operation.
   2. Description: ADA compliant, battery powered, chrome plated faucet.
      a. Body Material: Commercial, solid brass.
      b. Finish: Polished chrome plate.
      c. Maximum Flow Rate: 0.5 gpm.
      d. Centers: 4 inches.
      e. Mounting: Deck, exposed.
      f. Valve Handle(s): Not applicable.
      g. Inlet(s): NPS 3/8 tubing, plain end.
      h. Spout: Rigid type.

i. Spout Outlet: Laminar flow.
j. Operation: Battery operated sensor.
k. Drain: Offset lavatory grid strainer.
l. Tempering Device: Thermostatic mixing valve.
m. Refer to schedule on drawings for more information.

2.2 FLUSHOMETERS

A. Flushometers for Water Closets (P-1 and P-1A):
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Sloan Valve Company.
b. Zurn Plumbing Products Group; Commercial Brass Operation.
c. American Standard
2. Description: ADA compliant flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
a. Internal Design: Gear driven.
b. Style: Exposed.
c. Inlet Size: NPS 1.
d. Trip Mechanism: Battery-operated sensor actuator with manual override.
e. Consumption: Dual flush, low consumption, 1.6/1.1 gal./flush.
f. Tailpiece Size: NPS 1-1/2, adjustable length to top of bowl.
g. Refer to schedule on drawings for more information.

B. Flushometers for Urinals (P-2):
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Sloan Valve Company.
b. Zurn Plumbing Products Group; Commercial Brass Operation.
c. American Standard
2. Description: ADA compliant flushometer for urinal-type fixture. Include brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
a. Internal Design: Diaphragm operation.
b. Style: Exposed.
c. Inlet Size: NPS 3/4.
d. Trip Mechanism: Battery-operated sensor actuator with manual override button.
e. Consumption: 0.5 gal./flush.
f. Tailpiece Size: NPS 3/4 and adjustable length to top of bowl.
g. Refer to schedule on drawings for more information.

2.3 TOILET SEATS

A. Toilet Seats (P-1 and P-1A):
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Standard Companies, Inc.
b. Bemis Manufacturing Company.
c. Church Seats.
d. Eljer.
e. Kohler Co.
f. Olsonite Corp.

2. Description: Toilet seat for water-closet-type fixture.
a. Material: Molded, commercial heavy-duty, solid plastic.
b. Configuration: Open front without cover.
c. Size: Elongated.
d. Hinge Type: Plastic non self-sustaining check with non-corroding 300 series stainless steel posts and pintles.
e. Class: Heavy-duty commercial.
f. Color: White.

2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. McGuire Manufacturing Co., Inc.
b. TRUEBRO, Inc.
c. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.
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.

2.5 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Josam Company.
2. MIFAB Manufacturing Inc.
3. Smith, Jay R. Mfg. Co.
4. Tyler Pipe; Wade Div.
5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Water-Closet Supports:
1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

C. Urinal Supports:
1. Description: Type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

D. Lavatory Supports:

1. Description: Type II, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

2.6 WATER CLOSETS

A. Water Closets (P-1 and P-1A):
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Crane Plumbing, L.L.C./Fiat Products.
      b. American Standard Companies, Inc.
      c. Eljer.
      d. Kohler Co.
      e. TOTO USA, Inc.
   2. Description Standard and Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Style: Flushometer valve.
         1) Bowl Type: Elongated with siphon-jet design.
         2) Design Consumption: 1.6/1.1 gal./flush.
         3) Color: White.
      b. Supply Spud Size: 1-1/2”
      c. Trapway Size: 2-1/8”
      d. Fixture Support: Water-closet support combination carrier.
      e. Refer to schedule on drawings for more information.

2.7 URINALS

A. Urinals (P-2):
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. American Standard Companies, Inc.
      b. Crane Plumbing, L.L.C./Fiat Products.
      c. Eljer.
      d. Kohler Co.
      e. TOTO USA, Inc.
   2. Description: Standard and Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Washout.
      b. Strainer or Trapway: Open trapway with integral trap.
      c. Design Consumption: 0.5 gal./flush.
      d. Color: White.
      e. Supply Spud Size: NPS 3/4.
      f. Outlet Size: NPS 2.
      g. Fixture Support: Urinal chair carrier.
      h. Refer to schedule on drawings for more information.

2.8 LAVATORIES

A. Wall-Mount Single User Lavatories (P-3):

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Standard Companies, Inc.
   b. Eljer.
   c. Kohler Co.
   d. Crane Plumbing, L.L.C./Fiat Products.
   e. Gerber Plumbing Fixtures LLC.
   f. TOTO USA, Inc.
2. Description: Accessible, wall mounted, vitreous-china fixture.
   a. Type: D-shaped bowl, front overflow, self-draining deck area with contoured back and side splash shields.
   b. Size: 19-1/4 by 17-1/4 inches rectangular.
   c. Faucet Hole Punching: Three holes, 4-inch centers.
   d. Faucet Hole Location: Faucet Ledge.
   e. Pedestal: Not required.
   f. Color: White.
   g. Drain: Grid with offset waste.
      1) Location: Near back of bowl.
   h. Drain Piping: NPS 1-1/4 by NPS 1-1/2 chrome-plated, cast-brass P-trap; NPS 1-1/2, 0.045-inch-thick tubular brass waste to wall; and wall escutcheon.
   i. Refer to schedule on drawings for more information.

B. Multi-Station Lavatories (P-4):
1. Description: Two-station, lavatory system with standard lavatory spacing positioned 30-inches on center. Accessible, wall-mounted, forward curved lavatory deck with rounded edges, molded from engineered stone material (natural quartz and granite) to create a seamless and integral elongated basin, with stainless steel enclosed pedestal cabinet. Refer to schedule on drawings for more information.

2.9 SERVICE BASINS

A. Mop Service Basins (P-5):
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Acorn Engineering Company.
   b. Crane Plumbing, L.L.C./Fiat Products.
   c. Florestone Products Co., Inc.
   d. Precast Terrazzo Enterprises, Inc.
   e. Mustee, E. L. & Sons, Inc.
   f. Zurn Plumbing Products Group; Light Commercial Operation.
2. Description: Terrazzo, pre-cast corner mop sink composed of marble chips cast in Portland cement. Refer to drawings for additional information.
   a. Shape: Neo-Corner series.
   b. Size: 24 by 24 inches.
   c. Height: 12 inches with 6 inch high front shoulder.
   d. Tiling Flange: Galvanized steel on two sides (if required, coordinate with architectural finish drawings).

e. Rim Guard: On all top surfaces.
f. Color: White.
g. Faucet: Service sink faucet, chrome-plated with vacuum breaker, integral stops, adjustable wall brace, pail hook and ¾" hose thread on spout. Body inlets 8" center to center, four arm handles. Valves shall contain renewable hub, renewable seats, swivel discs, encased washers, and brass washer screws. Shall be complete with eyewash and drench hose. Refer to schedule on drawings for additional requirements.
h. Drain: Grid with NPS 3 outlet.

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 plumbing fixture installation.
B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
D. Install wall-mounting fixtures with tubular waste piping attached to supports.
E. Install counter-mounting fixtures in and attached to casework.
F. Install fixtures level and plumb according to roughing-in drawings.
G. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section, "General-Duty Valves for Plumbing Piping."
H. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
I. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
J. Install toilet seats on water closets.
K. Install traps on fixture outlets.
1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
L. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal

protruding fittings. Escutcheons are specified in Division 22 Section, "Escutcheons for Plumbing Piping."

M. Set service basins in leveling bed of cement grout. Grout is specified in Division 22 Section, "Common Work Results for Plumbing."

N. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section, "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. 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 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following water coolers and related components:
   1. Water coolers.
   2. Fixture supports.

1.3 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
B. Cast Polymer: Dense, cast-filled polymer plastic.
C. Fitting: Device that controls flow of water into or out of fixture.
D. Fixture: Drinking fountain or water cooler unless one is specifically indicated.
E. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.4 SUBMITTALS

A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Field quality control test reports.
D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act" for fixtures for people with disabilities.
C. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
D. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
E. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: Two of each type installed for each fixture.

PART 2 - PRODUCTS

2.1 WATER COOLERS

A. Water Coolers, Bi-Level Wall Mounted, with Bottle Filler (P-6):
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Elkay Manufacturing Co.
      b. Halsey Taylor.
      c. Haws Corporation.
   2. Description: Self-contained, wall mounted, electric, two-level water cooler with bottle filling station. Bottle filling unit shall include an automatic 20-second shut-off timer, visual user interface displaying bottles saved from waste and filter replacement, and provide 1.1 to 1.5 GPM flow rate with laminar flow to minimize splashing. Unit shall meet ADA guidelines, have lead-free design certified to meet NSF/ANSI 61 and 372, be certified to UL399. Refer to drawings for additional information.
      a. Cabinet: Light gray granite finish.
      b. Bubbler: One, vandal-resistant, located on each deck.
      c. Control: Vandal-resistant, front and side pushbars. Electronic bottle filler sensor.
      d. Supply: NPS 3/8 with ball, gate, or globe valve.
      e. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
      f. Drain: Grid with NPS 1-1/2 minimum horizontal waste and trap complying with ASME A112.18.2.
      g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, R-134A refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
         1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
         2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.

2.2 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Josam Co.
   2. MIFAB Manufacturing, Inc.
   3. Smith, Jay R. Mfg. Co.
   4. Tyler Pipe; Wade Div.

5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
6. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
1. Type I: Hanger-type carrier with two vertical uprights.
2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
B. Examine walls and floors for suitable conditions where fixtures are to be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
B. Use mounting frames for recessed water coolers, unless otherwise indicated.
C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section, "General-Duty Valves for Plumbing Piping."
E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section, "Escutcheons for Plumbing Piping."
G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section, "Joint Sealants."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
C. Ground equipment according to Division 26 Section, "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Division 26 Section, "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
   1. Remove and replace malfunctioning units and retest as specified above.
   2. Report test results in writing.

3.6 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.
B. Adjust water cooler temperature settings.

3.7 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

SECTION 230511 - COMMON WORK RESULTS FOR HVAC

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

A. The requirements of this Section apply to all sections of Division 23.

B. Definitions:

1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
2. Option or optional: Contractor's choice of an alternate material or method.

1.3 QUALITY ASSURANCE

A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified.

B. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
3. Conform to codes and standards as required by the specifications. Conform to local codes, if the local codes are more stringent than those specified.
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

C. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.

D. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

E. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Engineer for resolution.
2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

1.4 SUBMITTALS

A. Submit in accordance with Division 01, and with requirements in the individual specification sections.

B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

D. Prior to submitting shop drawings for approval, contractor shall verify that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.

F. Layout Drawings:
1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas.
2. The drawings shall include plan views, elevations and sections of all systems. Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.

3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
4. In addition, for HVAC systems, provide details of the following:
   a. Mechanical equipment rooms.
   c. Hangers, inserts, supports, and bracing.
   d. Pipe sleeves.
   e. Duct or equipment penetrations of floors, walls, ceilings, or roofs.

G. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment.
2. Submit electric motor data and variable speed drive data with the driven equipment.
3. Equipment and materials identification.
4. Fire-stopping materials.
5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
6. Wall, floor, and ceiling plates.

H. HVAC Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Division 01, for systems and equipment.
2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

I. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing and Commissioning Subcontractor.

L. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

M. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. Air Conditioning, Heating and Refrigeration Institute (AHRI):

430-2009..... Central Station Air-Handling Units

C. American National Standard Institute (ANSI):

B31.1-2007 ..... Power Piping

D. Rubber Manufacturers Association (ANSI/RMA):

IP-20-2007 ..... Specifications for Drives Using Classical V-Belts and Sheaves

IP-21-2009 ..... Specifications for Drives Using Double-V (Hexagonal) Belts

IP-22-2007 ..... Specifications for Drives Using Narrow V-Belts and Sheaves

E. Air Movement and Control Association (AMCA):

410-96 Recommended Safety Practices for Air Moving Devices

F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007..... Power Boilers
Section IX-2007 ..... Welding and Brazing Qualifications
Code for Pressure Piping:
B31.1-2007 ..... Power Piping
G. American Society for Testing and Materials (ASTM):
A36/A36M-08..... Standard Specification for Carbon Structural Steel
A575-96(2007)..... Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
E84-10 Standard Test Method for Surface Burning Characteristics of Building Materials
E119-09c ..... Standard Test Methods for Fire Tests of Building Construction and Materials
H. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
SP-58-2009..... Pipe Hangers and Supports-Materials, Design and Manufacture, Selection, Application, and Installation
SP 69-2003..... Pipe Hangers and Supports-Selection and Application
SP 127-2001..... Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application
I. National Electrical Manufacturers Association (NEMA):
MG-1-2009..... Motors and Generators
J. National Fire Protection Association (NFPA):
31-06 Standard for Installation of Oil-Burning Equipment
54-09 National Fuel Gas Code
70-08 National Electrical Code
85-07 Boiler and Combustion Systems Hazards Code
90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems
101-09 Life Safety Code

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:
1. Equipment and material placed on the job site shall remain in the custody of the Contractor. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in first class, new operating condition; or, replace same. Such repair or replacement shall be at no additional cost to the Owner.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:
1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.

2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

PART 2 - PRODUCTS

2.1 REFER TO SCHEDULES AND EQUIPMENT NOTES ON DRAWINGS FOR BASIS OF DESIGN MATERIALS, MANUFACTURERS AND MODEL NUMBERS.

2.2 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
   1. All components of an assembled unit need not be products of same manufacturer.
   2. Constituent parts that are alike shall be products of a single manufacturer.
   3. Components shall be compatible with each other and with the total assembly for intended service.
   4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.3 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.4 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.5 ELECTRIC MOTORS

A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 13, COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

2.7 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals.

2.8 FIRESTOPPING

A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork.

2.9 GALVANIZED REPAIR COMPOUND

A. Mil. Spec. DOD-P-21035B, paint form.

2.10 PIPE PENETRATIONS

A. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Structural Engineer.

B. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

2.11 DUCT PENETRATIONS

A. Provide curbs for roof mounted ductwork and equipment. Curbs shall be 24 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.

B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

2.12 SPECIAL TOOLS AND LUBRICANTS

A. Furnish, and turn over to the Owner, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

C. Refrigerant Tools: Provide system gauges, fittings, and tools required for maintenance of furnished equipment.

D. Tool Containers: Metal, permanently identified for intended service and mounted, or located, where directed by the Owner.

2.13 WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Thickness: Not less than 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025-inch for up to 3-inch pipe, 0.035-inch for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.14 ASBESTOS

Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified. Contractor shall provide all equipment, ductwork, piping, valves, access doors, hangers, fittings and miscellaneous components not necessarily detailed on these drawings to render the mechanical systems complete, operable, and in accordance with applicable codes and generally accepted industry standards. The drawings are diagrammatic in nature and do not show all ductwork, piping, fittings, offsets, routing, etc. Contractor shall provide all necessary components and coordinate final routing during the coordination process.

B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.

C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

E. Cutting Holes:

1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by Owner’s Representative where working area space is limited.
2. Locate holes to avoid interference with structural members such as beams. Holes shall be laid out in advance and drilling done only after approval by Owner’s Representative. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Owner’s Representative for approval.
3. Do not penetrate membrane waterproofing.

F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

G. Electrical Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items in the opinion of the Owner’s Representative, shall be replaced.
2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

I. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

J. Work in Existing Building:
1. Perform as specified in Division 01 – General Requirements.
2. As specified in Division 01 – General Requirements, make alterations to existing service piping at times that will least interfere with normal operation of the facility.

K. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone

3.2 TEMPORARY PIPING AND EQUIPMENT

A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.

B. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.3 RIGGING

A. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

B. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

C. Rigging plan and methods shall be referred to the Owner’s Representative for evaluation prior to actual work.

3.4 PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Structural Engineer.

B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.

C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 1/2-inch clearance between pipe or piping covering and adjacent work.

D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.

E. Overhead Supports:

1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.

F. Floor Supports:

1. Provide structural steel systems for support of equipment and piping. Anchor and dowel structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Do not locate or install bases and supports until equipment mounted thereon has been approved.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

3.5 MECHANICAL DEMOLITION

A. In an operating facility, maintain the operation, cleanliness and safety. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of operation. Perform all flame cutting to maintain the fire safety integrity. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards.

B. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of

the other disciplines in the project for additional facilities to be demolished or handled.

C. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from the property expeditiously and shall not be allowed to accumulate.

3.6 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the facilities for beneficial use by the Owner, the facilities, equipment and systems shall be thoroughly cleaned.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this. Lead based paints shall not be used.

3.7 STARTUP AND TEMPORARY OPERATION

A. Startup equipment as described in equipment specifications.

B. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Owner.

D. The Commissioning Agent will observe startup and Contractor testing of selected equipment. Coordinate the startup and Contractor testing schedules with Owner's Representative and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.8 ENHANCED STARTUP AND TESTING

A. Preliminary Requirements: Provide the services of a Factory Trained Representative for the following:

1. Inspect system installations prior to start-up.
2. Supervise and perform initial start-up of equipment.
3. Instruction of School District Personnel, refer to training section for additional information.

B. Mechanical System Pre-Start-Up and Start-Up:

1. Upon completion of mechanical system installations, the Factory Trained Representative shall visit the site, inspect the installations and notify the School District's Representative of any Work which must be done or modified prior to start-up.

2. Upon completion of required Work, or modifications to installed Work and miscellaneous testing, all as required by the particular mechanical system or apparatus, the Factory Trained Representative shall supervise the mechanical system start-up.
3. Start-up the system and conduct a preliminary test, for the purpose of checking the general operation of the system, proving mechanical and electrical controls and making necessary adjustments.
4. Provide pre-start-up check list, start-up list and operating instructions for the system, framed under rigid plastic and place where directed.

C. Adjustments, Preliminary Testing and Operational Testing: The following shall be performed by a Factory Trained Representative:

1. Adjustments: Place the system in operation with automatic controls functioning. Adjust controls and apparatus for proper operation. Test all thermometers, gages and sensors for accuracy over the entire range. Remove and replace items found defective.
   i. Provide a point-to-point control check of the system to ensure that the specified inputs and outputs are receiving the signal from the proper sensors or controlling the proper device.
   ii. Set pressure controls and safety controls.
   iii. Close or de-energize all solenoids, and start-up the system.
   iv. Check that all controls and safety switches are operating properly.
2. Preliminary Testing:
   i. Adjust the completed system and then operate it long enough to assure that it is performing properly.
   ii. Run a preliminary test for the purpose of:
      1) Determining whether the system is in a suitable condition to conduct an operational test.
      2) Checking and adjusting equipment, controls, safety features, interlocks, etc.
3. Training School District personnel.
4. Operational Testing:
   i. Place system in operation, with final connections to equipment and with automatic controls operating, and operate for a minimum of 24 consecutive hours.
   ii. Operational test shall prove to the satisfaction of the School District's Representative that the system is operating as required by the drawings and the specifications. Provide notice 3 working days prior to test so arrangements can be made to have a School District Representative witness the test.
   iii. Make the following tests:
      1) Test system operational functions step by step.
      2) Test monitor and control devices.
      3) Test all remote devices such as valve and damper actuators to demonstrate full range of motion.
5. Supply all equipment necessary for system adjustment and testing.
6. Submit written report of test results signed by the Factory Trained Representative.

1) Unforeseen Deferred Tests. If any check or test cannot be completed due to project conditions, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the School District's Representative. These tests will be conducted in the same manner as the seasonal tests as soon as possible.
2) Seasonal Testing. Seasonal testing (tests delayed until weather conditions are closer to the system's design conditions) shall be completed as part of this contract. Make any final adjustments to the O&M manuals and as-builts resulting from information gained during testing.
3) Perform tests as required for commissioning provisions in accordance with Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

3.8 OPERATING AND PERFORMANCE TESTS

A. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Owner.
B. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.
C. Perform tests as required for commissioning provisions in accordance with Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

3.9 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
B Components provided under this section of the specification will be tested as part of a larger system.

3.9 DEMONSTRATION AND TRAINING

A. The Contractor shall be responsible for coordinating, scheduling, and documenting that all required training has been completed successfully.
B. Training time shall be exclusive of all pre-start-up, start-up, testing and service call time. Duration of training shall be as required for sufficient emersion of School District personnel in the use of the equipment and systems. Unless otherwise noted in the specifications (refer to specification 230900) a minimum of (3) 8-hour training sessions shall be provided for (4) School District employees.
C. The contractor shall engage Factory Trained Representatives to perform training of School District personnel.
D. The Contractor shall have the following training responsibilities:
   1. Provide a training plan two weeks before the planned training.
   2. Provide comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment.

3. Training shall normally start with classroom sessions (virtual classroom sessions are permitted) followed by hands-on training on each piece of equipment.
4. The training sessions shall illustrate whenever possible the use of the O&M manuals for reference.
5. At a minimum training shall include:
    i. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
    ii. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, and any emergency procedures.
    iii. Common troubleshooting problems and solutions.
    iv. Discussion of any peculiarities of equipment installation or operation.
    v. Give an overview of each system and explain each system feature in detail.
    vi. Show each piece of equipment and explain its function.
    vii. Demonstrate the system configuration, using one-line diagrams or other graphic techniques.
    viii. Narrate the system description, explaining acronyms, technical terms, system concepts, and functions during the course of the system description narration.
    ix. Thoroughly explain and demonstrate all system operation, programming, and maintenance functions. Include warnings, where applicable, to preclude incorrect system procedures.
    x. Step by step instruction for programming all system functions.
    xi. Procedures required for installing items which are provided as spare parts for the system.
    xii. Preventive maintenance required for each piece of equipment for the system.
    xiii. Refer to other specification sections for additional training requirements.

END OF SECTION 230511

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 ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.
C. Comply with IEEE 841 for severe duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
E. Multispeed Motors: Separate winding for each speed.
F. Rotor: Random wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
H. Temperature Rise: Match insulation rating.
I. Insulation: Class F.
J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse width modulated inverters.
   2. Energy and Premium Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable torque, permanent split capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS 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. Sleeves.
   2. Grout.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Galvanized Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
B. Galvanized Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post hardening and volume adjusting, dry, hydraulic cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000 psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve seal system.
C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

D. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 SLEEVE AND SLEEVE SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller Than NPS 6: Galvanized steel wall sleeves.
      b. Piping NPS 6 and Larger: Galvanized steel wall sleeves.
   2. Concrete Slabs above Grade:
      a. Piping Smaller Than NPS 6: Galvanized steel pipe sleeves.
   3. Interior Partitions:
      a. Piping Smaller Than NPS 6: Galvanized steel pipe 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 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One Piece, Cast Brass Type: With polished, chrome-plated finish and setscrew fastener.
B. One Piece, Deep Pattern Type: Deep drawn, box shaped brass with chrome-plated finish and spring clip fasteners.
C. One Piece, Stamped Steel Type: With chrome-plated finish and spring clip fasteners.
D. Split Casting Brass Type: With polished, chrome-plated and rough brass finish and with concealed hinge and setscrew.
E. Split Plate, Stamped Steel Type: With chrome-plated finish, concealed hinge, and spring clip fasteners.

2.2 FLOOR PLATES

A. One Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern type.
      b. Chrome-Plated Piping: One piece, cast brass or split casting brass type with polished, chrome-plated finish.
      c. Insulated Piping: One piece, stamped steel type or split plate, stamped steel type with concealed hinge or split plate, stamped steel type with exposed rivet hinge.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass or split casting brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, stamped steel type or split plate, stamped steel type with concealed hinge or split plate, stamped steel type with exposed rivet hinge.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass or split casting brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, stamped steel type or split plate, stamped steel type with concealed hinge or split plate, stamped steel type with exposed rivet hinge.
h. Bare Piping in Unfinished Service Spaces: One piece, cast brass or split casting brass type with polished, chrome-plated.
i. Bare Piping in Unfinished Service Spaces: One piece, stamped steel type or split plate, stamped steel type with concealed hinge or split plate, stamped steel type with exposed rivet hinge.
j. Bare Piping in Equipment Rooms: One piece, cast brass or split casting brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One piece, stamped steel type or split plate, stamped steel type with concealed hinge or split plate, stamped steel type with exposed rivet hinge.

2. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split plate, stamped steel type with concealed or exposed rivet hinge.
   c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting brass type with polished, chrome-plated finish.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate, stamped steel type with concealed or exposed rivet hinge.
   e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting brass type with polished, chrome-plated finish.
   f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel type with concealed or exposed rivet hinge.
   g. Bare Piping in Unfinished Service Spaces: Split casting brass type with polished, chrome-plated finish.
   h. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel type with concealed or exposed rivet hinge.
   i. Bare Piping in Equipment Rooms: Split casting brass type with polished, chrome-plated finish.
   j. Bare Piping in Equipment Rooms: Split plate, stamped steel type with concealed or exposed rivet hinge.

C. Install floor plates for piping penetrations of equipment room floors.
D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One piece, floor plate type.
2. Existing Piping: Split casting, floor plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

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. Thermal hanger shield inserts.
   4. Fastener systems.
   5. Pipe stands.
   6. Equipment supports.

B. Related Sections:
   1. Division 05 Section "Metal Fabrications" for structural steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   3. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Pipe stands.
   4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon Steel Pipe Hangers and Supports:
1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:
1. Description: MSS SP-58, Types 1 through 58, copper-coated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop or field-fabricated pipe support assembly made from structural carbon steel shapes with MSS SP-58 carbon steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL HANGER SHIELD INSERTS

A. 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. Carpenter & Paterson, Inc.
2. Clement Support Services
3. ERICO International Corporation
4. National Pipe Hanger Corporation
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100 psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125 psig minimum compressive strength and vapor barrier.
C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100 psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125 psig minimum compressive strength.
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.

2.4 FASTENER SYSTEMS
A. Powder-Actuated Fasteners: Threaded steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
B. Mechanical Expansion Anchors: Insert-wedge type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 PIPE STANDS
A. General Requirements for Pipe Stands: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support floor-mounted piping.
B. High Type, Multiple Pipe Stand:
1. Bases: One or more; plastic.
2. Vertical Members: Two or more protective-coated steel channels.
3. Horizontal Member: Protective-coated steel channel.
4. Pipe Supports: Galvanized steel, clevis-type pipe hangers.

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

2.7 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, carbon steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION
A. Metal Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. Metal Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
C. Thermal Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
F. Equipment Support Installation: Fabricate from welded-structural steel shapes.
G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
H. Install lateral bracing with pipe hangers and supports to prevent swaying.
I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 <and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
L. Insulated Piping:
    1. Attach clamps and spacers to piping.
        a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        b. Piping Operating below Ambient Air Temperature: Use thermal hanger shield insert with clamp sized to match OD of insert.
        c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
    2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        a. Option: Thermal hanger shield inserts may be used. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
    3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
        a. Option: Thermal hanger shield inserts may be used. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
    4. Shield Dimensions for Pipe: Not less than the following:
        a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
        b. NPS 4: 12 inches long and 0.06 inch thick.
        c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    5. Thermal Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure overhead.
B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
    1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
E. Use carbon steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
F. Use copper-plated pipe hangers for uninsulated copper piping and tubing.
G. Use padded hangers for piping that is subject to scratching.
H. Use thermal hanger shield inserts for insulated piping and tubing.
I. Horizontal Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
    1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F,pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel pipe base stanchion support and cast iron floor flange or carbon steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel pipe base stanchion support and cast iron floor flange or carbon steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel pipe base stanchion support and cast iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction 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 not necessary.
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 not necessary.
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.

J. Vertical Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

K. Hanger Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

O. Comply with MSS SP-69 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 powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS 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. Elastomeric isolation pads.
   2. Elastomeric isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Open-spring isolators.
   5. Housed-spring isolators.
   6. Restrained-spring isolators.
   7. Housed-restrained-spring isolators.
   8. Elastomeric hangers.
   9. Spring hangers.
   10. Snubbers.
   11. Restraints - rigid type.
   12. Restraints - cable type.
   13. Restraint accessories.
   14. Post-installed concrete anchors.
   15. Concrete inserts.
   16. Restrained isolation roof-curb rails.

1.3 DEFINITIONS

A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.
B. IBC: International Building Code.
C. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
   2. Include load rating for each wind-force-restraint fitting and assembly.
   3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and wind-force-restraint component.
   4. Annotate to indicate application of each product submitted and compliance with requirements.
   5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
B. Shop Drawings:
   1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittals:
1. For each wind-load protection device that is required by this Section or is indicated on Drawings, submit the following:
a. Wind-Load Restraint, and Vibration Isolation Base Selection: Select vibration isolators, and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
d. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared under "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
e. Qualified Professional Engineer: All designated-design submittals for wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.
2. Wind-Restraint Detail Drawing:
a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.
3. All delegated design submittals for wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
4. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
B. Qualification Data: For professional engineer.
C. Welding certificates.
D. Field quality-control reports.

E. Wind-Force Performance Certification: Provide special certification for HVAC components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.
1. Provide equipment manufacturer's written certification for each designated HVAC device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Provide manufacturer's written certification for each designated louver, damper, or similar device, stating that it will remain in place and protect opening from penetration of windborne debris and comply with all requirements of authorities having jurisdiction.
3. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.
4. The following HVAC systems and components require special certification for high wind performance. Written special certification of resistance to the effects of high wind force and impact damage must be provided by manufacturer:
a. All roof mounted equipment.

1.6 QUALITY ASSURANCE
A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wind- load control system.
1. Wind-Load Performance: Equipment to withstand the effects of high wind events determined in accordance with ASCE/SEI 7-16.
B. Wind-Load Design Calculations:
1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.
a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.
b. Refer to wind design data on structural drawing S001.
2. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.

2.2 ELASTOMERIC ISOLATION PADS
A. Elastomeric Isolation Pads:

1. Source Limitations: Obtain elastomeric isolation pads from single manufacturer.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
    a. Surface Pattern: Smooth, ribbed, or waffle pattern.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:
1. Source Limitations: Obtain double-deflection, elastomeric isolation mounts from single manufacturer.
2. Mounting Plates:
    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
1. Source Limitations: Obtain restrained elastomeric isolation mounts from single manufacturer.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    a. Housing: Cast-ductile iron or welded steel.
    b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:
1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators from single manufacturer.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
   1. Source Limitations: Obtain freestanding, laterally stable, open-spring isolators in two-part telescoping housing from single manufacturer.
   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
      b. Top housing with attachment and leveling bolt.

2.7 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
   1. Source Limitations: Obtain restrained-spring isolators from single manufacturer.
   2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
      a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
      b. Top plate with threaded mounting holes.
      c. Internal leveling bolt that acts as blocking during installation.
   3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
   4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
   1. Source Limitations: Obtain freestanding, open-spring isolators with vertical-limit stop restraints from single manufacturer.
   2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases limit floor load to 500 psig.
      b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.9 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
   1. Source Limitations: Obtain elastomeric hangers from a single manufacturer.
   2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.10 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
   1. Source Limitations: Obtain spring hangers from single manufacturer.
   2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
   8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
   9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.11 SNUBBERS

A. Source Limitations: Obtain snubbers from single manufacturer.
B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors.
   2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
   3. Anchors in Masonry: Design in accordance with TMS 402.
   4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.12 RESTRAINTS - RIGID TYPE

A. Source Limitations: Obtain rigid-type restraints from single manufacturer.
B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end

and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.13 RESTRAINTS - CABLE TYPE

A. Source Limitations: Obtain cable-type restraints from single manufacturer.

B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.14 RESTRAINT ACCESSORIES

A. Source Limitations: Obtain restraint accessories from single manufacturer.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.15 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Source Limitations: Obtain mechanical anchor bolts from single manufacturer.
2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Source Limitations: Obtain adhesive anchor bolts from single manufacturer.
2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.16 CONCRETE INSERTS

A. Source Limitations: Obtain concrete inserts from single manufacturer.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

2.17 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Source Limitations: Obtain restrained isolation roof-curb rails from single manufacturer.
B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand wind forces.
C. Upper Frame: To provide continuous support for equipment and to be captive to resiliently resist wind forces.
D. Lower Support Assembly: To be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. Lower support assembly to have a means for attaching to building structure and a wood nailer for attaching roof materials, and to be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Mount adjustable, restrained-spring isolators on elastomeric vibration isolation pads and provide access ports, for level adjustment, with removable waterproof covers at all isolator locations. Locate isolators so they are accessible for adjustment at any time during the life of the installation without interfering with integrity of roof.
E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.18 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
    1. Powder coating on springs and housings.
    2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
    3. Baked enamel or powder coat for metal components on isolators for interior use.
    4. Color code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and wind control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static, wind load, and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND WIND-LOAD CONTROL DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on

Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide wind-load control devices for systems and equipment where indicated in Equipment Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators, wind-load restraints, must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   2. Install wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.

G. Install wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

I. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

J. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

K. Mechanical Anchor Bolts:
   1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
   2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
   3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors to be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
   4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
   5. Set anchors to manufacturer's recommended torque, using a torque wrench.
   6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails and bases, concrete inertia bases, and restrained isolation roof-curb rails with requirements of isolated equipment specified in this and other Sections. Where dimensions of these bases are indicated on Drawings, dimensions may require adjustment to accommodate actual isolated equipment.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.6 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. Perform tests and inspections with the assistance of a factory-authorized service representative.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 HVAC VIBRATION CONTROL AND SEISMIC RESTRAINT DEVICE SCHEDULE

A. Refer to details and schedules on drawings for types and locations.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION 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. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black.
   4. Maximum Temperature: Able to withstand temperatures up to 250 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: 1/2 inch
   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 unique equipment number.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
B. Letter Color: White.
C. Background Color: Red.
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: 1/2 inch
G. Fasteners: Stainless steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, and an arrow indicating flow direction.
    1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
    2. Lettering Size: At least 1-1/2 inches high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
    1. Stencil Material: Fiberboard or metal.
    2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray can form.
    3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2 inch numbers.
    1. Tag Material: Brass, 0.032 inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
    2. Fasteners: Brass wire link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2-by-11 inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
    1. Valve tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Reinforced grommet and wire or string.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 DUCT LABEL INSTALLATION

A. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction.
B. Locate labels on ductwork in penthouses only.

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; hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
B. Valve Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve Tag Size and Shape:
      a. 1-1/2 inches round.
   2. Valve Tag Color:
      a. Natural

3. Letter Color:
   a. Black

3.6 WARNING TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 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. Testing, Adjusting, and Balancing of Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
   2. Testing, adjusting, and balancing of equipment.
   3. HVAC-control system verification.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, adjusting, and balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
F. TDH: Total dynamic head.
G. UFAD: Underfloor air distribution.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
   1. Minimum Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Needs for coordination and cooperation of trades and subcontractors.
      d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
B. Contract Documents Examination Report: Within 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 90 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 90 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
F. Certified TAB reports.
G. Sample report forms.
H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.6 QUALITY ASSURANCE
A. TAB Specialists Qualifications, Certified by NEBB or TABB:
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
C. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.7 FIELD CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)
PART 3 - EXECUTION

3.1 TAB SPECIALISTS
A. Subject to compliance with requirements, available TAB specialists that may be engaged include, but are not limited to, the following:
   1. DL Flow Tech.

3.2 EXAMINATION
A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine ceiling plenums used for HVAC to verify that they are properly separated from adjacent areas and sealed.
F. Examine equipment performance data, including fan 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 operating safety interlocks and controls on HVAC equipment.

K. Examine heat-transfer coils for correct connections and for clean and straight fins.

L. Examine operating safety interlocks and controls on HVAC equipment.

M. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

N. 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.

3.3 PREPARATION

A. Prepare a TAB plan that includes the following:
1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
1. Airside:
   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume, smoke, and fire dampers are open and functional.
   d. Clean filters are installed.
   e. Fans are operating, free of vibration, and rotating in correct direction.
   f. Variable-frequency controllers' startup is complete and safeties are verified.
   g. Automatic temperature-control systems are operational.
   h. Ceilings are installed.
   i. Windows and doors are installed.
   j. Suitable access to balancing devices and equipment is provided.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in AABC's "National Standards for Total System Balance" ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230700 "HVAC 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.

3.5 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:
   1. Motors.
   2. Fans and ventilators.
   3. Condensing units.
   4. Rooftop air-conditioning units.
   5. Packaged air conditioners.
   6. Split-system air conditioners.
   7. Variable-refrigerant-flow systems.
   8. Heat pumps.
   9. Coils.
   10. Air terminal units.
   11. Cabinet unit heaters.

3.6 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

3.7 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure total airflow.
      a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
      b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.
      c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
   2. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report artificial loading of filters at the time static pressures are measured.
   3. Obtain approval from Engineer or Commissioning Authority 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.
   4. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, speed, volts, amps, and static profile.
   4. Mark all final settings.
   5. Test system in economizer mode. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.

7. Record final fan-performance data.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:
   1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
   2. Verify that the system is under static pressure control.
   3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   4. Measure fan static pressures as follows:
      a. Measure static pressure directly at the fan outlet or through the flexible connection.
      b. Measure static pressure directly at the fan inlet or through the flexible connection.
      c. Measure static pressure across each component that makes up the air-handling system.
      d. Report any artificial loading of filters at the time static pressures are measured.
   5. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
      a. Balance the return-air ducts and inlets.
      b. Verify that terminal units are meeting design airflow under system maximum flow.
   6. Re-measure the inlet static pressure at the most critical terminal unit, and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls Contractor.
   7. Verify final system conditions as follows:
      a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
      b. Re-measure and confirm that total airflow is within design.
      c. Re-measure final fan operating data, speed, volts, amps, and static profile.
      d. Mark final settings.
      e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
      f. Verify tracking between supply and return fans.

3.9 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.

3.10 PROCEDURES FOR AIR-COOLED CONDENSING UNITS

A. Verify proper rotation of fan(s).
B. Measure and record entering- and leaving-air temperatures.
C. Measure and record entering and leaving refrigerant pressures.
D. Measure and record operating data of compressor(s), fan(s), and motors.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Entering and leaving refrigerant pressure and temperatures.

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. Air pressure drop.
5. Voltage and amperage input of each phase at full load.
6. Calculated kilowatt at full load.
7. Fuse or circuit-breaker rating for overload protection.

3.12 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:
1. Verify HVAC 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.

3.13 TOLERANCES

A. Set HVAC system's airflow rates flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.

2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.14 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for system-balancing devices. Recommend changes and additions to system-balancing devices, to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance-measuring and -balancing devices.

B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.15 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
1. Fan curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:
a. Indicated versus final performance.
b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans performance forms, including the following:
    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Heating coil, dry-bulb conditions.
    e. Face and bypass damper settings at coils.
    f. Fan drive settings, including settings and percentage of maximum pitch diameter.
    g. Variable-frequency controller settings for variable-air-volume systems.
    h. Settings for pressure controller(s).
    i. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Balancing stations.
4. Position of balancing devices.

E. Rooftop-Unit Test Reports: For rooftop units, include the following:
1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and speed.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan speed.

d. Inlet and discharge static pressure in inches wg.
e. For each filter bank, filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
j. Outdoor airflow in cfm.
k. Return airflow in cfm.
l. Outdoor-air damper position.
m. Return-air damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig.
j. Refrigerant suction temperature in deg F.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and speed.
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 and in air terminal 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, and split system indoor units with outside air intake include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.

h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and speed.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave and amount of adjustments in inches.
   g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Outside airflow rate in cfm (where applicable).
   c. Total system static pressure in inches wg.
   d. Fan speed.
   e. Discharge static pressure in inches wg.
   f. 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 fan and air-handling-unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft..
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

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 of terminal units, include the following:

1. Unit Data:
   a. System 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-air temperature in deg F.
   c. Leaving-air temperature in deg F.

M. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.16 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.
2. If the second final inspection also fails, Owner may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.17 ADDITIONAL TESTS

A. 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.

B. Refer to Section 230800 “Commissioning of HVAC” for project commissioning requirements.

END OF SECTION 230593

SECTION 230700 - HVAC 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:
   1. Insulation Materials:
      a. Cellular glass.
      b. Flexible elastomeric.
      c. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Mastics.
   5. Lagging adhesives.
   6. Sealants.
   7. Factory-applied jackets.
   8. Field-applied jackets.
   9. Tapes.
   10. Securements.
   11. Corner angles.

B. Related Sections:
   1. Division 22 Section "Plumbing Insulation."
   2. Division 23 Section "Metal Ducts" for duct liners.

1.3 SUBMITTALS

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

B. Shop Drawings:
   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.
   8. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

D. 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. Fire Test Response Characteristics: Insulation and related materials shall have fire test response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

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

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 size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

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

1.7 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

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

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

F. Flexible Elastomeric: Closed cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. CertainTeed Corp.; Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; All-Service Duct Wrap.

H. Mineral Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. CertainTeed Corp.; Commercial Board.
b. Fibrex Insulations Inc.; FBX.
c. Johns Manville; 800 Series Spin-Glas.
d. Knauf Insulation; Insulation Board.
e. Manson Insulation Inc.; AK Board.
f. Owens Corning; Fiberglas 700 Series.

I. Mineral Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Insulco, Division of MFS, Inc.; Triple I.
b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral Fiber, Hydraulic Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Insulco, Division of MFS, Inc.; SmoothKote.
      b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

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: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. P.I.C. Plastics, Inc.; Welding Adhesive.
      d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of <Insert value> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. ITW TACC, Division of Illinois Tool Works; CB-50.
      d. Marathon Industries, Inc.; 590.
      e. Mon-Eco Industries, Inc.; 55-40.
      f. Vimasco Corporation; 749.
   2. Water Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-10.
      b. Foster Products Corporation, H. B. Fuller Company; 35-00.
      c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
      d. Marathon Industries, Inc.; 550.
      e. Mon-Eco Industries, Inc.; 55-50.
      f. Vimasco Corporation; WC-1/WC-5.
   2. Water Vapor Permeance: ASTM F 1249, 3 perms at 0.0625 inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 200 deg F.
   4. Solids Content: 63 percent by volume and 73 percent by weight.
   5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. For indoor applications, use lagging adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-52.
      b. Foster Products Corporation, H. B. Fuller Company; 81-42.
      c. Marathon Industries, Inc.; 130.

d. Mon-Eco Industries, Inc.; 11-30.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F.
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Aluminum.
   6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. ASJ Flashing Sealants, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products, Division of ITW; CP-76.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, elastomeric sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: White.
   6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
   1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
   2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
   3. FSK Jacket: Aluminum foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. PVC Jacket: High-impact resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto PVC Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

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.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, 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. Factory-Fabricated Fitting Covers:
      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short and long radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.9 TAPES

A. ASJ Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   4. Adhesion: 90 ounces force/inch in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
      b. Compac Corp.; 130.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
      d. Venture Tape; 1506 CW NS.
   2. Width: 2 inches.
   3. Thickness: 6 mils.
   4. Adhesion: 64 ounces force/inch in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum Foil Tape: Vapor retarder tape with acrylic adhesive.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
      b. Compac Corp.; 120.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
      d. Venture Tape; 3520 CW.
   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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
      c. RPR Products, Inc.; Bands.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:
1. Capacitor Discharge Weld Pins: Copper or zinc-coated steel pin, fully annealed for capacitor discharge welding, 0.106 inch diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped Head, Capacitor Discharge Weld Pins: Copper or zinc-coated steel pin, fully annealed for capacitor discharge welding, 0.106 inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper or zinc-coated, low carbon steel fully annealed, 0.106 inch diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Self-Sticking Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
2) GEMCO; Press and Peel.
3) Midwest Fasteners, Inc.; Self Stick.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper or zinc-coated, low carbon steel fully annealed, 0.106 inch diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

5. Insulation Retaining Washers: Self-locking washers formed from 0.016 inch thick, galvanized steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.
D. Wire: 0.080 inch nickel-copper alloy
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. C & F Wire.
      b. Childers Products.
      c. PABCO Metals Corporation.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. 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 equipment, ducts and fittings, and piping including fittings, valves, and specialties.

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

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

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

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

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

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3 inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self sealing lap. Staple laps with outward clinching staples along edge at [2 inches] [4 inches] o.c.
      a. For below ambient services, apply vapor barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
P. For above ambient services, do not install insulation to the following:
1. Vibration control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS
A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at 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: Install insulation continuously through penetrations of fire rated walls and partitions. Terminate insulation at fire damper sleeves for fire rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" firestopping and fire-resistive joint sealers.
E. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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. Pipe: Install insulation continuously through floor penetrations.

3. Seal penetrations through fire rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

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

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

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by

tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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

3.6 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 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.

C. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed valve covers manufactured of same material as pipe insulation when available.
   2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.
   4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 MINERAL FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor discharge weld pins and speed washers or cupped-head, capacitor discharge weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not 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 1 edge and 1 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.
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.

F. 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 1 edge and 1 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.

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.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with 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.
B. Where metal jackets are indicated, install with 2 inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
B. Do not field paint aluminum jackets.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply and outdoor air.
   2. Indoor, exposed supply and outdoor air.
   3. Indoor, concealed return located in nonconditioned space (above ceiling is to be considered nonconditioned space).
   4. Indoor, exposed return located in nonconditioned space.
   5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
   6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
B. Items Not Insulated:
   1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
   2. Factory-insulated flexible ducts.
   3. Factory-insulated plenums and casings.
   4. Flexible connectors.
   5. Vibration control devices.
   6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct insulation shall be the following:
   1. Mineral Fiber Blanket: 1-1/2 inches thick, R-6 minimum R-value.
B. Concealed, return-air duct insulation shall be the following:
   1. Mineral Fiber Blanket: 1-1/2 inches thick, R-6 minimum R-value.
C. Concealed, outdoor-air duct insulation shall be the following:

1. Mineral Fiber Blanket: 1-1/2 inches thick, R-6 minimum R-value.

D. Concealed, relief-air duct insulation shall be the following:
   1. Mineral Fiber Blanket: 1-1/2 inches thick, R-6 minimum R-value.

E. Exposed, supply-air duct insulation shall be the following:
   1. Mineral Fiber Board: 1-1/2 inches thick, R-6 minimum R-value.

F. Exposed, return-air duct insulation shall be the following:
   1. Mineral Fiber Board: 1-1/2 inches thick, R-6 minimum R-value.

G. Exposed, outdoor-air duct insulation shall be the following:
   1. Mineral Fiber Board: 1-1/2 inches thick, R-6 minimum R-value.

H. Exposed, relief-air duct insulation shall be the following:
   1. Mineral Fiber Board: 1-1/2 inches thick, R-6 minimum R-value.

3.12 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. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate (gravity and pumped) and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
      b. Flexible Elastomeric: 1 inch thick.

B. Refrigerant Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Piping, Exposed:
   1. PVC: 40 mils thick.
   2. Aluminum, with Z-Shaped Locking Seam: 0.016 inch thick.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

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 commissioning process requirements for HVAC&R systems, assemblies, and equipment.
B. Related Sections:
   1. Division 26 Section "Commissioning of Electrical Systems".
   2. Division 22 Section “Commissioning of Plumbing Systems”.
   3. Division 28 Section “Commissioning of Digital, Addressable Fire-Alarm System.”

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
B. CxA: Commissioning Authority.
C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Provide all labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing.
B. Perform commissioning tests at the direction of the CxA.
C. Attend construction phase controls coordination meeting.
D. Attend testing, adjusting, and balancing review and coordination meeting.
E. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
F. Provide information requested by the CxA for final commissioning documentation.
G. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Direct commissioning testing.
C. Verify testing, adjusting, and balancing of Work are complete.
D. Provide test data, inspection reports, and certificates in Systems Manual.

E. The CxA will be appointed by and work directly for the School District.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
   1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
   2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
   3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
   4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
   5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
   6. Test and inspection reports and certificates.
   7. Corrective action documents.
   8. Verification of testing, adjusting, and balancing reports.

1.7 SUBMITTALS

A. Certificates of readiness.
B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
E. Inspect and verify the position of each device and interlock identified on checklists.
F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
   1. The CxA will notify testing and balancing Subcontractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
   4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS
A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
D. The CxA shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
E. Tests will be performed using design conditions whenever possible.
F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
G. The CxA may direct that set points be altered when simulating conditions is not practical.
H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTED
A. At a minimum the following items listed below are to be tested as part of the commissioning process, refer to the specifications for additional requirements:
   1. Variable air volume boxes and associated components.

2. Ductless split air conditioning system and associated components.
3. Perimeter heating elements (finned tube radiation, unit heaters, etc.) and associated components.
4. Rooftop units and associated components.
5. Exhaust fan systems and associated components.
6. HVAC automatic temperature controls systems and sequences of operations.

END OF SECTION 230800

SECTION 230900 – BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.0 CONTROL SYSTEM DESCRIPTION

A. The intent of this project is to have a Trane Tracer Building Automation System installed.

B. The new Tracer Building system will provide controls to all equipment indicated on the drawings. The Trane system will operate independently of the schools separate BMS.

C. All Trane Controls Products to be bought directly by Orange Ulster BOCES for installation.

D. All controls products, control equipment, software, hardware, programming, graphics, wiring and conduit specified in this section shall be provided by Trane.

E. Provide labor, controls materials, controls equipment and services as required for a complete BACnet Building Automation System (BAS), to perform the functions described in this Section. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.

F. It is the BAS manufacturer's responsibility to provide all the design, engineering, and field coordination required to ensure all equipment sequence of operations are met as specified and the designated BAS operators have the capability of managing the building mechanical system.

G. 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.

H. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.

I. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and equipment on this project.

J. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

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.

1.1 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION (will be provided to and installed by mechanical contractor)

1. Control Valves
2. Variable frequency drives (to be provided and installed by mechanical contractor)
3. Flow Switches
4. Temperature Sensor Wells and Sockets
5. Hydronic Pressure Taps
6. Hydronic Flow meters
7. Automatic Dampers

1.2 APPROVED CONTROL SYSTEM MANUFACTURERS

A. Manufacturer: Subject to compliance with requirments, provide products by the following:
   1. Trane (Lauren Hayes 518-410-9375 Lauren.hayes@tranetechnologies.com)

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 in order 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 in order 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. BAS manufacturer shall provide shop drawings and manufacturers' standard specification data sheets on all hardware and software being provided for this project. No work may begin on any segment of this project until the Engineer and Owner have reviewed submittals for conformity with the plan and specifications. Six (6) copies are required. All shop drawings shall be provided to the Owner electronically once they have been approved and as-built drawings have been completed.

B. Quantities of items submitted shall be reviewed by the Engineer and Owner. Such review shall not relieve the BAS manufacturer of furnishing quantities required based upon contract documents.

C. Provide the Engineer and Owner, any 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.
D. Submit the following within 90 days of contract award:
   1. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
   2. 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.
   3. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
   4. Provide all manufacturers' technical cut sheets for major system components.
   5. Provide proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements
   6. Provide detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls provided by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.
   7. Provide points list showing all system objects and the proposed English language object names.
   8. Provide a sequence of operation for each controlled mechanical system and terminal enddevices.
   9. Provide a 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.

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. Database back-up
      b. Operation coaching

2. Technician shall review critical alarm log and advise owner of additional services that may be required.
3. Technician shall provide a written report to owner 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. 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.
B. 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:
      i. 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.
      ii. Each communication interface shall be ZigBee certified as a BACnet tunneling device as allowed by the BACnet Standard and defined by the Zigbee Alliance.
      iii. 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.
      iv. 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 provide a similar user experience for facility managers and occupants.
      v. 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.

vi. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.

vii. 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.

viii. To maintain robust communication, self-healing, redundant mesh networking and two-way communications shall be used to optimize the wireless network reliability.

ix. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.

x. 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.

xi. Space/wall sensors shall be available with temperature, relative humidity, occupancy, and CO2 to support common HVAC controls applications.

xii. Occupancy sensors shall be have adequate range, sensing patterns, and number of sensors required to provide 100% coverage.

xiii. CO2 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.

xiv. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

2.3 OPERATOR INTERFACE

A. Operator Web Interface shall conform to following:

1. System Security

i. 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.

ii. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.

iii. Each operator shall be allowed to change their user password.

iv. The System Administrator shall be able to manage the security for all other users.

v. The system shall include pre-defined “roles” that allow a system administrator to quickly assign permissions to a user.

vi. User logon/logoff attempts shall be recorded.

vii. 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

i. The operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:

(a) Move and edit any of the nodes of the tree.

(b) Move entire groups to any area of the tree

(c) Change the name of any node in the tree

(d) Create custom nodes for any page in the web interface including: graphics, data log views, schedules, and dashboards

(e) Support navigation from multi-building to single building view

(f) Ability to create folders and assign and change hierarchy of nodes of the tree

3. Standard Equipment Pages
   i. The operator web interface shall include standard pages for all major equipment.
   ii. These pages shall allow an operator to obtain information relevant to the operation of the equipment, including:
      (a) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
      (b) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
      (c) Data Logs for the equipment without requiring a user to navigate to a Data Log page and perform a filter.
4. System Graphics Package
   i. 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.
   ii. Graphics Package shall include at a minimum:
      (a) 3-D Color Site Map (for multiple building campus projects) or 3-D Building Rendering (for single building projects)
      (b) 3-D Color Custom Floor Plans
         (i) Floor Plan Graphics to show accurate ductwork of system
         (ii) Toggle Switch to turn ductwork on/off per each floor plan
         (iii) Indicate thermal comfort on floor plan graphics using colors to represent zone temperature relative to zone set point
      (c) 3-D Color Hydronic System Graphics with Animations
         (i) Example Animation: Pump Flashing when On
      (d) 3-D Color Major Equipment Graphics with Animations
         (i) Example Animation: Fan Spinning when On
5. Manual Control and Override
   i. Point Control. Provide 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.
   ii. 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
   i. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
7. Scheduling
   i. A user shall be able to perform the following tasks utilizing the operator web interface:
   ii. Create a new schedule, defining the default values, events and membership.
   iii. Create exceptions to a schedule for any given day.
   iv. Apply an exception that spans a single day or multiple days.
   v. View a schedule by day, week and month.
   vi. Exception schedules and holidays shall be shown clearly on the calendar.
   vii. Modify the schedule events, members and exceptions.
   viii. Create schedules and exceptions for multiple buildings

ix. Apply emergency schedule to multiple buildings
x. Drag and drop scheduling editing
xi. Global schedule and exceptions across multiple buildings

8. Data Logs
   i. Data Logs Definition.
      (a) The operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
   ii. Data Log Viewer.
      (a) The operator web interface shall allow Data Log data to be viewed and printed.
      (b) The operator web interface shall allow a user to view Data Log data in a text-based format (time –stamp/value).
      (c) The operator shall be able to view the data collected by a Data Log in a graphical chart in the operator web interface.
      (d) Data Log viewing capabilities shall include the ability to show a minimum of five points on a chart.
      (e) Each data point data line shall be displayed as a unique color.
      (f) Data points can be hidden on the display view by clicking on the point
      (g) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
      (h) The system shall provide a graphical trace display of the associated time stamp and value for any selected point along the x-axis.
   iii. Export Data Logs.
      (a) 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
   i. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
   ii. The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.
   iii. The system operator will have the option of setting specific times and days that that they will receive alarm notifications.
   iv. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator web interface.
      (a) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in categories based on severity.
      (b) 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
   i. The operator shall be able to view all logged user changes in the system from any operator web interface.
      (a) 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.
      (b) 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
    i. The operator web interface shall provide a reporting package that allows the operator to select reports to run.
    ii. The operator web interface shall provide the ability to schedule reports to run at specified intervals of time.
    iii. The Enterprise operator web interface shall provide the ability to email schedule reports at specified intervals of time.
    iv. The following standard reports shall be available without requiring a user to manually design the report:
        (a) All Points in Alarm Report: Provide an on demand report showing all current alarms.
        (b) All Points in Override Report: Provide an on demand report showing all overrides in effect.
        (c) Schedules Report: List of all weekly events for all schedules in selected buildings
        (d) 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:
    i. BACnet Testing Laboratory (BTL) Listed

2.4 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. Provide 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.

2.5 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 provided 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 provided 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.

G. Serviceability – The Controller shall provide 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

2.6 APPLICATION-SPECIFIC CONTROLLERS

A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controller, The ontroller shall use programs provided 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 provided 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.

G. Serviceability – The Controller shall provide 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

2.7 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 20□F-140□F. 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 shall be provided as an integral part of the relays.

H. Valve and Damper Actuators
1. Electronic Direct-Coupled: Electronic direct-coupled actuation shall be provided.
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 provided with 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.

I. Control Valves: Provide 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, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, provide valves which 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: Provide control ball valves for control of terminal units including, but not necessarily limited to, convectors, thinned tube radiation, and fan coil - units that are of integral motor type. Provide 2-position or modulating type valves, electrically actuated by line voltage or by 24VAC.

J. Dampers: Provide automatic control low leakage, opposed blade dampers, with damper frames not less than formed 13-gauged galvanized steel. Provide mounting holes for enclosed duct mounting. Provide 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. Provide blade bearings Nylon and provide 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 10 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.

PART 3 EXECUTION

3.1 COORDINATION

A. Provide power 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 60 inches above the floor.

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. Install raceways, boxes, and cabinets according to Section 260533 “Raceways and Boxes for Electrical Systems.”
B. Install building wire and cable according to Section 260519 “Low-Voltage Electrical Power Conductors and Cables.”
C. Install signal and communication cable accroding to Section 271500 “Communciations Horizontal Cabling.”
D. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used provided that 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).
E. 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.
F. 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.
G. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, the BAS manufacturer shall provide step-down transformers to achieve the desired control voltages.
H. 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.
I. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment
J. 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.
K. 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.
L. 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.
M. 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.
N. 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:
      i. a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
      ii. b. Verify that DDC controllers are protected from power supply surges.
D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
E. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Owner’s Representative and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.5 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

3.6 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer’s written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

B. Adjust initial temperature set points.

3.7 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.

3.8 TRAINING

A. Provide two training sessions of four (8) 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. Provide a walk-through of the building and review the location of room sensors and unit controllers.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related Sections include the following:

1. Division 23 Section, "HVAC Instrumentation and Control" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. VAV: Variable air volume.

1.4 SUBMITTALS

A. Shop Drawings: Indicate mechanical system controlled and control system components.

1. Label with settings, adjustable range of control and limits. Include written description of control sequence.
2. Include flow diagrams for each control system, graphically depicting control logic.
3. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

1.5 CLOSEOUT SUBMITTALS

A. Project Record Documents: Record actual locations of components and set-points of controls, including changes to sequences made after submission of shop drawings.

1.6 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment listed below and indicated on drawings along with all associated control elements shall be graphically represented on the Building Management System (BMS).

B. For equipment listed below and indicated on drawings, manual override capabilities shall be provided through the BMS.

C. Refer to the points list on the drawings for BMS inputs and outputs.

D. All set-points indicated below shall be adjustable.

E. Thermostat Set-points:
   1. Occupied Heating Set-point: 70 degrees F
   2. Occupied Cooling Set-point: 75 degrees F
   3. Unoccupied Heating Set-point: 67 degrees F
   4. Unoccupied Cooling Set-point: 80 degrees F
   5. Deadband: 5 degrees F

F. Provide commissioning documentation in accordance with the requirements of Section 230800,

3.2 COMMISSIONING OF HVAC SYSTEMS.

A. Operations provided under this section of the specification will be tested as part of a larger system.

3.3 GENERAL EXHAUST FANS (EF-1)

A. Exhaust fans shall be sequenced on by the BMS during programmed “occupied” time periods. The fans shall be shut-down during “unoccupied” time periods. Each fan shall have individual scheduling capability. When the exhaust fan is called to activate the associated motorized exhaust air damper shall open and then the fan shall turn on. The exhaust fan shall not turn on until the associated motorized damper is open. Whenever the exhaust fan is shut-down the associated motorized exhaust air damper shall be closed. A current sensor on the exhaust fan and an end switch on the motorized damper shall provide fan status and damper position. If the fan does not turn on or the damper does not open, an alarm shall be provided at the BMS.

B. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM. Fire alarm system shall shut-down exhaust fan.

C. Refer to “General Roof Exhaust Fan Controls Schematic” on drawings.

3.4 STORAGE ROOM EXHAUST FAN (EF-2)

A. Exhaust fans shall be sequenced on by the BMS during programmed “occupied” time periods. The fans shall be shut-down during “unoccupied” time periods. Each fan shall have individual scheduling capability. When the exhaust fan is called to activate the associated motorized exhaust air and intake air damper shall open and then the fan shall turn on. The exhaust fan shall not turn on until the associated motorized dampers are open. Whenever the exhaust fan is shut-down the associated motorized exhaust and intake air dampers shall be closed. A current sensor on the exhaust fan and an end switch on the motorized dampers shall provide fan status and damper position. If the fan does not turn on or the dampers do not open, an alarm shall be provided at the BMS.

B. During unoccupied periods, on a rise in space temperature above set-point the motorized dampers associated with the exhaust fan shall open and the exhaust fan shall turn on. The exhaust fan shall continue to run until the space temperature falls below set-point, at which point the fan shall stop and the motorized dampers shall close.

C. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM. Fire alarm system shall shut-down exhaust fan.

D. Refer to “Storage Room Exhaust Fan Controls Schematic” on drawings.

3.5 ELECTRIC FINNED TUBE HEATERS (EH-A)

A. The electric heating element shall be turned on/off as required to maintain space set-point. Coordinate temperature sensor settings for electric heating elements with base HVAC equipment serving same spaces.

3.6 ELECTRIC CABINET UNIT HEATERS (EH-B)

A. Provide a space sensor arranged to energize electric heating element as required to maintain space set-point. Whenever electric heating element is energized the unit fan shall be operational.

B. Electric heaters located in vestibules shall be arranged to prevent heating when the outdoor air temperature is greater than 45°F. The thermostat set-point for the vestibules shall be no greater than 60°F.

3.7 ELECTRIC UNIT HEATERS (EH-C)

A. The factory thermostat shall energize electric heating elements as required to maintain space temperature set-point. Whenever the electric heating element is energized the unit fan shall be operational.

B. A BMS space temperature sensors shall be provided to monitor space temperature. The space temperature sensor shall be used to control exhaust EF-2, refer to EF-2 sequence provided elsewhere in this section. In the Fire Pump Room, the space temperature sensor shall be tied into the controls associated with the fire pump.

3.8 SPLIT SYSTEM AIR CONDITIONERS (AC-A/ACCU-A and AC-1/HP-1)

A. System shall be operated through factory wireless remote controller, capable of providing set-point adjustments and all programming for control sequences. The system shall cycle On/Off (cooling and/or heating and indoor unit fan) as required to maintain space set-point. The system shall be provided with a BACnet interface as required to tie system operation into the BMS.

B. The Factory Installed controls shall be configured such that a Leak detector mounted in the indoor unit drain pan shall be arranged to shut-down the system when water is detected. BMS shall monitor condensate overflow and provide an alarm.

C. A BMS space temperature sensor shall be provided in each space to monitor space temperature and to provide a high temperature alarm.

3.9 SPLIT SYSTEM AIR CONDITIONERS (AC-2/HP-2)

A. System shall be operated through factory wireless remote controller, capable of providing set-point adjustments and all programming for control sequences. The system shall cycle On/Off (cooling or heating and indoor unit fan) as required to maintain space set-point. The system shall be provided with a BACnet interface as required to tie system operation into the BMS.

B. The Factory Installed controls shall be configured such that a Leak detector mounted in the indoor unit drain pan shall be arranged to shut-down the system when water is detected. BMS shall monitor condensate overflow and provide an alarm.

C. When the system is in scheduled occupied mode, the indoor unit fan shall be on and run continuously. The motorized damper located in the outside air intake ductwork shall be open, when in occupied mode. When in scheduled unoccupied mode, the indoor unit fan shall be off and the associated outside air intake motorized damper shall be closed.

D. A BMS space temperature sensor shall be provided in each space to monitor space temperature and to provide a high temperature alarm. Coordinate temperature settings with electric perimeter heating elements.

3.10 CONSTANT VOLUME PACKAGED ROOFTOP UNIT (RTU-1)

A. The system shall be automatically operated through the BMS when control panel mounted “On-Auto-Off” switch and “Summer-Auto-Winter” switch are indexed to the “Auto” position.

B. Occupied Cycle:

1. Summer Operation: Unit supply fan and exhaust fans shall run continuously with the control circuit energized. The outside air damper shall open to minimum position, the return damper shall be full open and relief damper shall open to the minimum position. Provide a duct sensor in the supply fan discharge reset by a return air sensor (master/sub-master) arranged to cycle the DX cooling and modulate hot gas reheat in stages as required to maintain space temperature and humidity set-points.
2. Winter Operation: Unit supply fan and exhaust fans will operate continuously with control circuits energized. The outside air intake and relief air dampers shall open to minimum position with the return air damper open to the maximum position. The discharge air sensor shall modulate gas heating as required to maintain an adjustable discharge temperature set-point.
3. Economizer Operation: On a call for cooling when outdoor air conditions permit (temperature and differential enthalpy) the system shall operate in economizer mode. The building management system shall modulate the outside air intake, relief and return air dampers, to maintain discharge air set-point. Discharge air temperature set-point shall be reset by return air sensor. Control action shall be that on a rise in discharge temperature above set-point the outside air damper and relief damper shall modulate towards the open position and the return damper shall modulate towards the closed position. When the outside air damper reaches full open position and upon a further call for cooling the system shall revert to normal Summer Operation and DX cooling shall begin. When ambient conditions are no longer suitable for economizer operation the unit controls shall revert to normal Summer Operation. Economizer operation shall be available during both “occupied” and “unoccupied” modes.

C. Unoccupied Cycle: When operating in winter mode the system shall cycle the unit supply and exhaust fans and modulate gas heating to maintain a setback temperature of 55º (adjustable). When operating in summer mode the system shall cycle the unit fan and stage DX cooling (unless economizer operation is available) to maintain a setback temperature of 80º (adjustable). During this cycle the outside air and relief air dampers shall remain closed, the return air damper shall be open.

D. Warm-up Cycle: When operating in the winter mode the unit shall start and operate on 100% recirculation with modulating gas heating during the warm-up periods programmed by the building management System. Upon reaching normal occupied space temperatures as determined through the return air sensor the system shall revert back to normal winter operation.

E. Morning Cool-Down: When operating in the summer mode the system shall start and operate on 100% recirculation (unless economizer operation is available) during the cool-down periods programmed by the BMS. DX cooling shall cycle on and modulate hot gas reheat in stages as required to maintain space temperature and humidity set-

points. Upon reaching normal occupied space temperatures as determined through the return air sensor the system shall revert back to normal summer operation.

F. General:
   1. Whenever the system is shut-down the outside air and relief air dampers shall remain closed and return air damper shall be open.
   2. Provide a low limit sensor in the unit discharge arranged to prevent winter discharge temperature from dropping below 60ºF (adjustable).
   3. Provide a high limit sensor in the unit discharge arranged to prevent winter discharge temperature from rising above 120 ºF (adjustable).
   4. Provide supply fan shut-down interlocked with the fire alarm system on systems greater than 1000 CFM.
   5. Systems larger than 2000 CFM shall shut-down upon detection of smoke as sensed by duct mounted smoke detector.
   6. Provide an airflow monitoring station in the outside air intake tied into the damper controls of the unit to maintain a constant flow rate of ventilation air. The BMS shall monitor and record airflow readings.

3.11 VARIABLE AIR VOLUME PACKAGED ROOFTOP UNIT (RTU-2 OR RTU-2A)

A. The system shall be automatically operated through the BMS when control panel mounted “On-Auto-Off” switch and “Summer-Auto-Winter” switch are indexed to the “Auto” position.

B. Occupied Cycle:
   1. Summer Operation: Unit supply fan (RTU-2 and RTU-2A) and exhaust fan (RTU-2A only) shall run continuously with the control circuit energized. The outside air damper shall open to minimum position, the return damper shall be full open and relief damper shall open to the minimum position. Provide a duct sensor in the supply fan discharge reset by a return air sensor (master/sub-master) arranged to cycle the DX cooling and modulate hot gas reheat in stages as required to maintain space temperature and humidity set-points.
   2. Winter Operation: Unit supply fan (RTU-2 and RTU-2A) and exhaust fan (RTU-2A only) will operate continuously with control circuits energized. The outside air intake and relief air dampers shall open to minimum position with the return air damper open to the maximum position. The discharge air sensor shall modulate gas heating as required to maintain an adjustable discharge temperature set-point.
   3. Economizer Operation: On a call for cooling when outdoor air conditions permit (temperature and differential enthalpy) the system shall operate in economizer mode. The building management system shall modulate the outside air intake, relief and return air dampers, to maintain discharge air set-point. Discharge air temperature set-point shall be reset by return air sensor. Control action shall be that on a rise in discharge temperature above set-point the outside air damper and relief damper shall modulate towards the open position and the return damper shall modulate towards the closed position. When the outside air damper reaches full open position and upon a further call for cooling the system shall revert to normal Summer Operation and DX cooling shall begin. When ambient conditions are no longer suitable for economizer operation the unit controls shall revert to normal Summer Operation. Economizer operation shall be available during both “occupied” and “unoccupied” modes.

C. Unoccupied Cycle: When operating in winter mode the system shall cycle the unit supply fan (RTU-2 and RTU-2A) and exhaust fan (RTU-2A only) and modulate gas heating to maintain a setback temperature of 55º (adjustable). When operating in summer mode the system shall cycle the unit fan and stage DX cooling (unless economizer operation is available) to maintain a setback temperature of 80º (adjustable). During this cycle the outside air and relief air dampers shall remain closed, the return air damper shall be open and room VAV boxes shall be open.

D. Warm-up Cycle: When operating in the winter mode the unit shall start and operate on 100% recirculation with modulating gas heating during the warm-up periods programmed by the building management System. Room VAV boxes shall be open. Upon reaching normal occupied space temperatures as determined through the return air sensor the system shall revert back to normal winter operation.

E. Morning Cool-Down: When operating in the summer mode the system shall start and operate on 100% recirculation (unless economizer operation is available) during the cool-down periods programmed by the BMS. Room VAV boxes shall be open. DX cooling shall cycle on and modulate hot gas reheat in stages as required to maintain space temperature and humidity set-points. Upon reaching normal occupied space temperatures as determined through the return air sensor the system shall revert back to normal summer operation.

F. Static Pressure Controls: Provide a static pressure sensor located on main supply duct approximately two-thirds (2/3) downstream from the longest run. Controls shall be arranged to modulate the unit variable frequency drives (VFD) on the supply fan to maintain a constant static pressure. A rise in pressure shall cause the VFD to reduce fan RPM. A drop in static pressure shall cause the reverse to take place.

G. General:
   1. Whenever the system is shut-down the outside air and relief air dampers shall remain closed and return air damper shall be open.
   2. Provide a low limit sensor in the unit discharge arranged to prevent winter discharge temperature from dropping below 60ºF (adjustable).
   3. Provide a high limit sensor in the unit discharge arranged to prevent winter discharge temperature from rising above 120 ºF (adjustable).
   4. Provide supply fan shut-down interlocked with the fire alarm system on systems greater than 1000 CFM.
   5. Systems larger than 2000 CFM shall shut-down upon detection of smoke as sensed by duct mounted smoke detector.
   6. Provide an airflow monitoring station in the outside air intake tied into the damper controls of the unit to maintain a constant flow rate of ventilation air. The BMS shall monitor and record airflow readings.

3.12 VARIABLE AIR VOLUME BOXES WITHOUT REHEAT (VAV-3)

A. During the occupied mode, the space sensor shall modulate the VAV box damper assembly to maintain set-point as programmed at the BMS. In summer mode, as determined by the BMS, a rise in space temperature shall cause the VAV damper to modulate open, as the space approaches set-point, the VAV damper shall modulate to the minimum (adjustable) position. In the winter mode, as determined by the BMS, a drop in space temperature as sensed by the space sensor shall cause the VAV damper to modulate open, as the space temperature approaches set-point, the VAV damper shall modulate to the minimum (adjustable) position to provide required tempered ventilation air.

B. The BMS shall reset the supply air temperature (ventilation, heating and cooling) based on satisfying the Terminal Unit that is either furthest from Set-point or the Terminal Unit that has the Highest air-flow while maintaining set-point.
C. When the rooftop unit is operating in the unoccupied, morning cool-down or warm-up cycle the boxes shall remain in the full open position.

3.13 VARIABLE AIR VOLUME BOXES WITH REHEAT COILS (VAV-1, 2 AND 4 TO 6)

A. During the occupied mode, the space sensor shall modulate the VAV box damper assembly to maintain set-point as programmed at the BMS. In summer mode, as determined by the BMS, a rise in space temperature shall cause the VAV damper to modulate open, as the space approaches set-point, the VAV damper shall modulate to the minimum (adjustable) position. In the winter mode, as determined by the BMS the VAV damper shall modulate to the minimum air-flow and on a call for heating the individual electric heating coil shall modulate on/off in stages as required. Once space set-point is reached the electric heating coil shall turn off and the VAV box damper shall remain at minimum position. Electric reheat shall be available when the system is operating in the summer mode.
   1. In the event of a no airflow condition, electric reheat coil operation shall be disabled.
B. The BMS shall reset the supply air temperature (ventilation and cooling) based on satisfying the Terminal Unit that is either furthest from Set-point or the Terminal Unit that has the Highest air-flow while maintaining set-point.
C. When the associated rooftop unit is operating in the unoccupied, morning cool-down or warm-up cycle the boxes shall remain in the full open position.

3.14 FIRE PUMP CONTROLS

D. On a call for fire pump operation the make-up and exhaust air motorized dampers located in the Fire Pump Room shall open, prior to the fire pump engine cranking. When the fire pump is no longer operational the make-up and exhaust air motorized dampers shall close. The motorized dampers shall fail open.
E. The space temperature sensor located in the Fire Pump Room shall energize the electric unit heater located in the space as required to maintain space temperature heating set-point. During space heating the motorized dampers located in the Fire Pump Room shall be closed. Upon an increase of space temperature above set-point the motorized dampers in the Fire Pump Room shall open, the reverse shall occur when space temperature is satisfied.
F. Fire pump operation shall override all other base building controls in the Fire Pump Room.
G. Coordinate with fire protection system contractor.

END OF SECTION 230993

SECTION 231123 - FACILITY NATURAL GAS 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. Pipes, tubes, and fittings.
   2. Piping and tubing joining materials.
   3. Valves.
   4. Pressure regulators.
   5. Dielectric fittings.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating Pressure Ratings:
   1. Piping and Valves: 100 psig minimum unless otherwise indicated.
   2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 2.0 psig but not more than 10 psig, and is reduced to secondary pressure of 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Comply with NFPA 54, Fuel Gas Code of NYS, and utility company standards.

1.5 SUBMITTALS

A. Product Data: For each type of the following:
   1. Piping specialties.
   2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
   3. Pressure regulators. Indicate pressure ratings and capacities.
   4. Dielectric fittings.

B. Shop Drawings: For facility natural gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the

same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
1. Shop Drawing Scale: 1/4 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Delegated-Design Submittal: For natural gas piping and equipment indicated to comply with performance requirements and design criteria.
D. Coordination Drawings: Plans and details, drawn to scale, on which natural gas piping is shown and coordinated with other installations, using input from installers of the items involved. Drawings are diagrammatic and may not show all piping. Contractor shall provide all necessary piping, pipe fittings, offsets, etc. as required for a complete system.
E. Welding certificates.
F. Field quality-control reports.
G. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE
A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Obtain each product type from single source from single manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural gas piping according to requirements of authorities having jurisdiction.
B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS
A. Interruption of Existing Natural Gas Service: Do not interrupt natural gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural gas supply according to requirements indicated:
1. Notify Owner no fewer than two days in advance of proposed interruption of natural gas service.
2. Do not proceed with interruption of natural gas service without Owner's written permission.

B. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
   1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
   2. Wrought Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
   3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
   4. Forged Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
      a. Material Group: 1.1.
      b. End Connections: Threaded or butt welding to match pipe.
      c. Lapped Face: Not permitted underground.
      d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
      e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
   5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive and PE.
      a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
   6. Mechanical Couplings:
      a. Steel flanges and tube with epoxy finish.
      b. NBR seals.
      c. Steel bolts, washers and nuts.
      d. Coupling is to be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
      e. Steel body couplings installed underground on plastic pipe are to be factory equipped with anode.

B. PE Pipe: ASTM D2513, SDR 11.
   1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
   2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
   3. Transition Service-Line Risers: Factory fabricated and leak tested.
      a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
      b. Outlet is threaded or flanged or suitable for welded connection.
      c. Bridging sleeve over mechanical coupling.
      d. Factory-connected anode.
      e. Tracer wire connection.
      f. UV shield.
      g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
   4. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Suitable for joining PE pipe to PE pipe.

a. PE body with molded-in, stainless steel support ring.
b. Seals: NBR.
c. Acetal collets.
d. Electro-zinc-plated steel stiffener.

5. Steel Mechanical Couplings: Suitable for joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   a. Steel flanges and tube with epoxy finish.
   b. Seals: NBR.
   c. Steel bolts, washers, and nuts.
   d. Factory-installed anode for steel-body couplings installed underground

2.2 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.
B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.3 MANUAL GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
   1. CWP Rating: 125 psig.
   2. Threaded Ends: Comply with ASME B1.20.1.
   3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
   5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
   1. CWP Rating: 125 psig.
   2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
   3. Tamperproof Feature: Locking feature for valves indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
C. Bronze Plug Valves: MSS SP-78.
   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. Lee Brass Company.
      b. McDonald, A. Y. Mfg. Co.
   2. Body: Bronze, complying with ASTM B 584.
   3. Plug: Bronze.
   4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
   5. Operator: Square head or lug type with tamperproof feature where indicated.
   6. Pressure Class: 125 psig.
   7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
   8. Service: Suitable for natural gas service with "WOG" indicated on valve body.

D. Cast Iron, Lubricated Plug Valves: MSS SP-78.
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. Flowserve.
b. Homestead Valve; a division of Olson Technologies, Inc.
c. McDonald, A. Y. Mfg. Co.
d. Milliken Valve Company.
e. Mueller Co.; Gas Products Div.
f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural gas service with "WOG" indicated on valve body.

E. PE Ball Valves: Comply with ASME B16.40.
1. Body: PE.
2. Ball: PE.
3. Stem: Acetal.
4. Seats and Seals: Nitrile.
5. Ends: Plain or fusible to match piping.
6. CWP Rating: 80 psig.
7. Operating Temperature: Minus 20 to plus 140 deg F.
8. Operator: Nut or flat head for key operation.
9. Include plastic valve extension.

F. Valve Boxes:
1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.4 PRESSURE REGULATORS
A. General Requirements:
1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Service Pressure Regulators: Comply with ANSI Z21.80A.
1. Body and Diaphragm Case: Cast iron or die-cast aluminum.
2. Springs: Zinc-plated steel; interchangeable.
3. Diaphragm Plate: Zinc-plated steel.
4. Seat Disc: NBR; resistant to gas impurities, abrasion, and deformation at the valve port.
5. Orifice: Aluminum; interchangeable.
6. Seal Plug: UV-stabilized, mineral-filled nylon.
7. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to regulator.
8. Pressure regulator is to maintain discharge pressure setting downstream and is to not exceed 150 percent of design discharge pressure at shutoff.
9. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
10. Maximum Inlet Pressure: 100 psig.

C. Line Pressure Regulators: Comply with ANSI Z21.80.
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. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

2.5 DIELECTRIC FITTINGS

A. Dielectric Unions:
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. Capitol Manufacturing Company.

b. Central Plastics Company.
c. Hart Industries International, Inc.
d. McDonald, A. Y. Mfg. Co.
e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:
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. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
d. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Advance Products & Systems, Inc.
b. Calpico Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
2. Minimum Operating-Pressure Rating: 150 psig.
3. Companion-flange assembly for field assembly.
4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
5. Insulating materials suitable for natural gas.
6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.6 LABELING AND INDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description and rated pressure of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for natural gas piping system to verify actual locations of piping connections before equipment installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
B. Inspect natural gas piping according to NFPA 54 and the Fuel Gas Code of New York State to determine that natural gas utilization devices are turned off in piping section affected.
C. Comply with NFPA 54 and the Fuel Gas Code of New York State requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the Fuel Gas Code of New York State for installation and purging of natural gas piping.
B. Install fittings for changes in direction and branch connections.
C. Install underground, natural-gas piping buried as per detail provided on drawings.
D. Install underground, PE, natural-gas piping in accordance with ASTM D2774.
E. Steel Piping with Protective Coating:
    1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
    2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
    3. Replace pipe having damaged PE coating with new pipe.

F. Install pressure gauge downstream from each service regulator.

3.4 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and the Fuel Gas Code of New York State for installation and purging of natural gas piping.
B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
C. 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. Locate valves for easy access.
E. Install natural gas piping at uniform grade of 2 percent down toward drip and sediment traps.
F. Install piping free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Verify final equipment locations for roughing-in.
I. Comply with requirements in Sections specifying gas-fired equipment for roughing-in requirements.
J. Drips and Sediment Traps: Install drips at points where condensate may collect. Locate where accessible to permit cleaning and emptying.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 6 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

K. Extend relief vent connections for line regulators to outdoors and terminate with weatherproof vent cap.
L. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
M. Connect branch piping from top or side of horizontal piping.
N. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
O. Do not use natural gas piping as grounding electrode.
P. Install sleeves for piping penetrations of walls, ceilings, and floors.
Q. Install escutcheons for piping penetrations of walls, ceiling and floors.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each piece of gas equipment.
B. Install underground valves with valve boxes.
C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
D. Install anode for metallic valves in underground PE piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded Joints:
   1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
   2. Cut threads full and clean using sharp dies.
   3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
   4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
   5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
D. Welded Joints:
   1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
   2. Bevel plain ends of steel pipe.
   3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural gas service. Install gasket concentrically positioned.
F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join in accordance with ASTM D2657.

   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section, "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
   5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Install natural gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

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

C. Connect piping to equipment using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

E. Connect to Owner’s gas main according to utility company’s procedures and requirements.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section, "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting exterior natural gas piping.

B. Paint exposed, exterior metal piping, valves, regulators, and piping specialties, except components, with factory-applied paint or protective coating.
   1. Alkyd System: MPI EXT 5.1D.
      a. Prime Coat: Alkyd anticorrosive metal primer.
      b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
      c. Topcoat: Exterior alkyd enamel (flat).
      d. Color: Gray.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and the Fuel Gas Code of New York State and authorities having jurisdiction.

C. Natural gas piping will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.12 PIPING SCHEDULE

A. Aboveground natural gas piping shall be one of the following:
   1. Steel pipe with malleable-iron fittings and threaded joints.
   2. Steel pipe with wrought steel fittings and welded joints.
B. Underground natural gas piping shall be one of the following:
   1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.

3.13 UNDERGROUND, MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
B. Underground:
   1. PE valves.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
   1. Bronze plug valve.
B. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
   1. Bronze plug valve.
   2. Cast iron, lubricated plug valve.

END OF SECTION 231123

SECTION 232113 - HYDRONIC 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. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
   1. Condensate-drain piping.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Plastic pipe and fittings with solvent cement.
   2. Copper pipe and fittings.
B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe hangers, supports for multiple pipes, and attachments of the same to the building structure.
C. Welding certificates.
D. Qualification Data: For Installer.
E. Field quality control test reports.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Wrought-Copper Fittings: ASME B16.22.

2.2 PLASTIC PIPE AND FITTINGS

A. Solid Wall PVC Pipe: ASTM D 2665, drain, waste and vent.
B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste and vent patterns.

2.3 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
B. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
C. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
D. Solvent Cements for Joining Plastic Piping:
    1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
        a. Use adhesive primer and a solvent cement that has a VOC content of 550 g/L and 510 g/L or less respectively when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
    1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        a. Charlotte Pipe and Foundry Company.
        b. IPEX Inc.
        c. KBi.
    2. PVC one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cement-joint end.
B. Plastic-to-Metal Transition Unions:
    1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        a. Charlotte Pipe and Foundry Company.
        b. IPEX Inc.
        c. KBi.
        d. NIBCO INC.
    2. MSS SP-107, PVC union. Include brass or copper end, Schedule 80 solvent-cement-joint end, rubber gasket, and threaded union.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
B. Insulating Material: Suitable for system fluid, pressure, and temperature.
C. Dielectric Unions:
    1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        a. Capitol Manufacturing Company.
        b. Central Plastics Company.
        c. Hart Industries International, Inc.
        d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
        e. Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
    2. Factory-fabricated union assembly, for 250 psig minimum working pressure at 180 deg F.
D. Dielectric Couplings:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Calpico, Inc.
   b. Lochinvar Corporation.
2. Galvanized steel coupling with inert and noncorrosive thermoplastic lining; threaded ends; and 300 psig minimum working pressure at 225 deg F.

E. Dielectric Nipples:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Perfection Corporation; a subsidiary of American Meter Company.
   b. Precision Plumbing Products, Inc.
   c. Sioux Chief Manufacturing Company, Inc.
2. Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig minimum working pressure at 225 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints where condensate piping is not located within an active air plenum. For locations where condensate piping is located within an active air plenum type L, drawn temper copper tubing, wrought-copper fittings and soldered joints shall be used.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. Contractor shall provide all required piping, piping offsets, fittings and etc. as required for a complete system.
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 at indicated slopes.
F. Install piping free of sags and bends.
G. Install fittings for changes in direction and branch connections.
H. Install piping to allow application of insulation.
I. Select system components with pressure rating equal to or greater than system operating pressure.
J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
K. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

L. 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.
M. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
N. Identify piping as specified in Division 23 Section, "Identification for HVAC Piping and Equipment."
O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section, "Sleeves and Sleeve Seals for HVAC Piping."
P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section, "Sleeves and Sleeve Seals for HVAC Piping."

3.3 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section, "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:
    1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
    2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
    3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
    4. Spring hangers to support vertical runs.
    5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
    6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
    1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
    2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
    3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
    5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
    6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
D. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    2. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.5 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. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
    3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
B. Perform the following tests on 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. Test piping in accordance with the Mechanical Code.
    3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
    4. Prepare written report of testing.

END OF SECTION 232113

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-454B:
   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.

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

F. Delegated Design Submittals: For refrigerant piping size and 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.

1.5 QUALITY ASSURANCE
A. Welding: Qualify procedures and personnel according to 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 in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION
A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section, "Roof Accessories."

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS
A. Copper Tube: ASTM B 280, Type ACR.
B. Wrought-Copper Fittings: ASME B16.22.
C. Wrought-Copper Unions: ASME B16.22.
D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
E. Brazing Filler Metals: AWS A5.8.

2.2 VALVES AND SPECIALTIES
A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.
B. Packed Angle Valves:
1. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.
C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.

7. Maximum Opening Pressure: 0.50 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.
8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig.
6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F.
6. Superheat: Adjustable.
7. Reverse-flow option (for heat pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig.

H. Hot Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   4. Working Pressure Rating: 500 psig.
   5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.
   5. Working Pressure Rating: 500 psig.
   6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
   1. Body: Forged brass.
   2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
   3. Indicator: Color coded to show moisture content in ppm.
   4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
   5. End Connections: Socket or flare.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted steel shell with ductile iron cover, stainless steel screws, and neoprene gaskets.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
   3. Desiccant Media: Activated alumina.
   4. Designed for reverse flow (for heat pump applications).
   5. End Connections: Socket.
   6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
   7. Maximum Pressure Loss: 2 psig.
   8. Working Pressure Rating: 500 psig.
   9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 730.
   1. Body and Cover: Painted steel shell.
   2. Filter Media: 10 micron, pleated with integral end rings; stainless steel support.
   3. Desiccant Media: Activated alumina.
   4. Designed for reverse flow (for heat pump applications).
   5. End Connections: Socket.
   6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
   7. Maximum Pressure Loss: 2 psig.
   8. Working Pressure Rating: 500 psig.
   9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or flare.
   3. Working Pressure Rating: 500 psig.
   4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.
   1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   2. Comply with UL 207; listed and labeled by an NRTL.
   3. Body: Welded steel with corrosion-resistant coating.
   4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
   5. End Connections: Socket or threaded.
   6. Working Pressure Rating: 500 psig.
   7. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.
   1. Body: Welded steel with corrosion-resistant coating.
   2. End Connections: Socket or threaded.
   3. Working Pressure Rating: 500 psig.
   4. Maximum Operating Temperature: 275 deg F.

2.3 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Atofina Chemicals, Inc.
   2. DuPont Company; Fluorochemicals Div.
   3. Honeywell, Inc.; Genetron Refrigerants.
   4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-454B: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-454B

A. Suction Lines NPS 3-1/2 and Smaller for Conventional Air Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

B. Hot Gas and Liquid Lines and Suction Lines for Heat Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

C. Safety Relief Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed or soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install packed-angle valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install packed-angle valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve 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 ASME Boiler and Pressure Vessel Code. Pipe safety relief valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
1. Solenoid valves.
2. Thermostatic expansion valves.
3. 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.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings. Contractor shall provide all required piping, piping offsets, fittings and etc. as required for a complete system.

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 adjacent to machines to allow service and maintenance.

F. Install piping free of sags and bends.

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

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

I. Refer to Division 23 Sections, "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

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 as specified in Division 08 Section, "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. 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.

M. 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.

N. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

O. Identify refrigerant piping and valves according to Division 23 Section, "Identification for HVAC Piping and Equipment."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section, "Sleeves and Sleeve Seals for HVAC Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section, "Sleeves and Sleeve Seals for HVAC Piping."

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

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. 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. Welded Joints: Construct joints according to AWS D10.12/D10.12M.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section, "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure. Test piping in accordance with the Mechanical Code of New York State.
   3. Test high and low pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
      a. Fill system with nitrogen to the required test pressure.
      b. System shall maintain test pressure at the manifold gage throughout duration of test.
      c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.7 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.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set point temperature of air conditioning or chilled water controllers to the system design temperature.
D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Open shutoff valves in condenser water circuit.
   2. Verify that compressor oil level is correct.
   3. Open compressor suction and discharge valves.
   4. Open refrigerant valves except bypass valves that are used for other purposes.
   5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 233113 - METAL 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. Single-wall rectangular ducts and fittings.
   2. Single-wall round ducts and fittings.
   3. Sheet metal materials.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

B. Related Sections:
   1. Division 23 Section, "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
   2. Division 23 Section, "Air Duct Accessories" for dampers, sound control devices, duct mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall 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. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.

9. Penetrations through fire rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

E. Welding certificates.

F. Field quality control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static pressure class unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Lindab Inc.
      b. McGill AirFlow LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," 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. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static pressure class, applicable sealing requirements, materials involved, duct support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements,available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Aeroflex USA Inc.
      b. Armacell LLC.
      c. Rubatex International, LLC
   2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
   3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
      a. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
   5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
   6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.
   6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:
   1. Supports for Galvanized Steel Ducts: Galvanized steel shapes and plates.

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. Contractor shall provide all required ductwork, ductwork offsets, fittings and etc. as required for a complete system.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section, "Air Duct Accessories" for fire and smoke dampers.
L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
    1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "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. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
    2. Use powder-actuated concrete fasteners for standard weight aggregate concretes or for slabs more than 4 inches thick.
    3. Do not use powder-actuated concrete fasteners for lightweight aggregate concretes or for slabs less than 4 inches thick.
C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers

and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section, "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 START UP

A. Air Balance: Comply with requirements in Division 23 Section, "Testing, Adjusting, and Balancing for HVAC."

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows.
   1. Refer to drawings for more information.

B. Ducts:
   1. Ducts Connected to Fan Coil Units:
      a. Pressure Class: Positive 1-inch wg.
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 12.
   2. Ducts Connected to Constant Volume Air Handling Units:
      a. Pressure Class: Positive 4-inch wg
      b. Minimum SMACNA Seal Class: A.
      c. SMACNA Leakage Class for Rectangular: 6
      d. SMACNA Leakage Class for Round and Flat Oval: 6.
   3. Ducts Connected to Variable Air Volume Air Handling Units:
      a. Pressure Class: Positive 4-inch wg.

b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

4. Ducts Connected to Equipment Not Listed Above:
   a. Pressure Class: Positive or negative 3-inch wg.
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 6.

C. Intermediate Reinforcement:
   1. Galvanized Steel Ducts: Galvanized steel.

D. Liner:
   1. Flexible elastomeric, 1-1/2 inches thick.
   2. Unless otherwise noted, provide acoustic lining a minimum of 25’-0” from inlet and outlet of all fans and a minimum of 5’-0” at the outlet of fan coil units and variable air volume boxes. Where interior ductwork ductwork is lined, external duct insulation may be omitted.

E. Double-Wall Duct Interstitial Insulation:
   1. Supply Air Ducts: 1 inch thick.

F. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "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 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
         1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
         2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.

3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.
2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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. Control dampers.
   4. Fire dampers.
   5. Combination fire and smoke dampers.
   6. Smoke dampers.
   7. Flange connectors.
   8. Turning vanes.
   9. Duct-mounted access doors.
   10. Flexible connectors.
   11. Flexible ducts.
   12. Duct accessory hardware.

B. Related Sections:
   1. Division 28 Section, "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control damper installations.
      d. Fire damper, smoke damper, combination fire and smoke damper installations, including sleeves; and duct-mounted access doors.
      e. Wiring Diagrams: For power, signal, and control wiring.

C. 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.

D. Source quality control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

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 2.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of air duct accessories and associated components that fail in materials or workmanship within manufacturer's standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G60.
   2. Exposed Surface Finish: Mill phosphatized.
C. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.
D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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. Duro Dyne Inc.
   2. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff; a division of PCI Industries, Inc.
   5. Ruskin Company.
B. Description: Gravity balanced.
C. Maximum Air Velocity: 2500 fpm.
D. Maximum System Pressure: 1-inch wg.
E. Frame: 18 gauge, galvanized sheet steel, with welded corners.
F. Blades: Multiple single-piece blades, maximum 6-5/8-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.
G. Blade Action: Parallel.

H. Blade Seals: Vinyl
I. Blade Axles:
   1. Material: Plated steel
   2. Diameter: 3/16-inch.
J. Tie Bars and Brackets: Galvanized steel.
K. Return Spring: Adjustable tension.
L. Bearings: Synthetic pivot bushings
M. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   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. Flexmaster U.S.A., Inc.
      b. McGill AirFlow LLC.
      c. METALAIRE, Inc.
      d. Nailor Industries Inc.
      e. Pottorff; a division of PCI Industries, Inc.
      f. Ruskin Company.
   2. Standard leakage rating with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat-shaped, galvanized steel channels, 0.064-inch minimum thickness.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   5. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized steel, 0.064 inch thick.
   6. Blade Axles: Galvanized steel.
   7. Bearings:
      a. Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   8. Tie Bars and Brackets: Galvanized steel.
B. Jackshaft:
   1. Size: 1-inch diameter.
   2. Material: Galvanized steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple damper assembly.
C. 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 CONTROL DAMPERS

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. Duro Dyne Inc.
   2. Flexmaster U.S.A., Inc.
   3. Greenheck Fan Corporation.
   4. McGill AirFlow LLC.
   5. METALAIRE, Inc.
   6. Nailor Industries Inc.
   7. Ruskin Company.

B. Low leakage rating with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:
   1. Hat shaped.
   2. Galvanized steel channels, 0.064 inch thick.
   3. Mitered and welded corners.

D. Blades:
   1. Multiple blade with maximum blade width of 8 inches.
   2. Parallel- and opposed blade design.
   3. Galvanized steel.
   4. 0.064 inch thick.
   5. Blade Edging: Closed-cell neoprene edging.
   6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:
   1. Molded synthetic.
   2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]
   1. Greenheck Fan Corporation.
   2. McGill AirFlow LLC.
   3. METALAIRE, Inc.
   4. Nailor Industries Inc.
   5. Pottorff; a division of PCI Industries, Inc.
   6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to 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 fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch thick, as indicated, and of length to suit application.
   2. Exception: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
G. Mounting Orientation: Vertical or horizontal as indicated.
H. Blades: Roll-formed, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized steel blade connectors.
I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
J. Heat Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.6 SMOKE DAMPERS
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. Air Balance Inc.; a division of Mestek, Inc.
   2. Cesco Products; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. Nailor Industries Inc.
   5. PHL, Inc.
   6. Ruskin Company.
B. General Requirements: Label according to UL 555S by an NRTL.
C. Smoke Detector: Integral, factory wired for single-point connection.
D. Frame: Curtain type with blades outside airstream fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized steel blade connectors.
F. Leakage: Class I.
G. Rated pressure and velocity to exceed design airflow conditions.
H. Smoke Detector: Provided by others, installed by mechanical contractor in ductwork.
I. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.
J. Damper Motors: Two-position action.
K. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section, "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section, "Instrumentation and Control for HVAC." and Division 26 Sections.
   3. Permanent-Split-Capacitor or Shaded Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for

service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:
1. Auxiliary switches for signaling and fan control.
2. Test and reset switches, damper mounted.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

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. Air Balance Inc.; a division of Mestek, Inc.
2. Cesco Products; a division of Mestek, Inc.
3. Greenheck Fan Corporation.
4. Nailor Industries Inc.
5. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 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; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

F. Heat Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Heat Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Smoke Detector: Provided by others, installed by mechanical contractor in ductwork.

I. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized steel blade connectors.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

M. Master control panel for use in dynamic smoke management systems.

N. Damper Motors: Two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section, "Common Motor Requirements for HVAC Equipment."
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section, "Instrumentation and Control for HVAC." and Division 26 Sections.
3. Permanent-Split-Capacitor or Shaded Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

P. Accessories:
1. Auxiliary switches for signaling and fan control.
2. Test and reset switches, damper mounted.

2.8 FLANGE CONNECTORS

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. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.9 TURNING VANES

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. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

2.10 DUCT-MOUNTED ACCESS DOORS

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. Ductmate Industries, Inc.

2. Flexmaster U.S.A., Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.
6. Pottorff; a division of PCI Industries, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
1. Door:
a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
d. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
a. Access Doors Less than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.

2.11 FLEXIBLE CONNECTORS

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. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Ventfabrics, Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 FLEXIBLE 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. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous glass insulation; [polyethylene] [aluminized] 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: See drawings.
C. Flexible Duct Connectors:
   1. Clamps: Stainless steel band with cadmium-plated hex screw to tighten band with a worm gear action in sizes 3 through 18 inches, to suit duct size.

2.13 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.
B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous glass ducts.
B. Install duct accessories of materials suited to duct materials; use galvanized steel accessories in galvanized steel.
C. Install backdraft and control dampers where indicated on plans and in controls specifications.
D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.
E. Set dampers to fully open position before testing, adjusting, and balancing.
F. Install test holes at fan inlets and outlets and elsewhere as indicated.
G. Install fire, smoke and combination fire smoke dampers according to UL listing.
H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On upstream side of duct coils.

2. Adjacent to and close enough to fire dampers, smoke dampers, or combination fire smoke dampers to reset or reinstall fusible links.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. Body Access: 25 by 14 inches.

K. Label access doors according to Division 23 Section, "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. Install duct test holes where required for testing and balancing purposes.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.

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. Flexible ducts, insulated.
   2. Flexible duct connectors.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Flexible ducts, insulated.
   2. Flexible duct connectors.
B. Product Data Submittals: For each type of product.
C. Shop Drawings: For flexible ducts.
   1. Include plans showing locations, mounting details, 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 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 must be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
C. Comply with the Air Duct Council's (formerly, Air Diffusion Council) "ADC Flexible Air Duct Test Code - FD 72-R1" and "Flexible Duct Performance & Installation Standards."
D. Comply with ASTM E96/E96M.

2.2 FLEXIBLE DUCTS, INSULATED

A. Standard: Product is to be UL 181 listed and bearing the UL label.
B. Flexible Ducts, Insulated - Class 1, Aluminum Laminate and Polyester Film with Latex Adhesive Supported by Helically Wound, Spring-Steel Wire; Fibrous-Glass Insulation:
   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. Flexmaster U.S.A., Inc.

2. Pressure Rating: 10 inch wg positive and 1.0 inch wg negative.
3. Maximum Air Velocity: 4000 fpm.
4. Temperature Range: Minus 20 to plus 210 deg F.
5. Insulation R-Value: R6.
6. Vapor-Barrier Film: Aluminized.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless steel band with stainless steel or zinc-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION OF FLEXIBLE DUCTS

A. Install flexible ducts in accordance with applicable details in the following publications:
   1. ADC's "Flexible Duct Performance & Installation Standards" for flexible ducts.
   2. NAIMA AH116.
   3. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
   4. SMACNA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.
B. Install in indoor applications only. Do not install flexible duct in locations where it will be exposed to UV lighting.
C. Connect diffusers and light troffer boots to ducts directly or with maximum 48-inch lengths of flexible duct clamped or strapped in place.
D. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
E. Installation:
   1. Install ducts fully extended.
   2. Do not bend ducts across sharp corners.
   3. Bends of flexible ducting must 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.
   6. Install in accordance with ADC instructions.
F. Supporting Flexible Ducts:
   1. Support flexible duct at manufacturer's recommended intervals, but at no greater distance than 4 ft.. Provide sufficient support so that maximum centerline sag is 1/2 in. per ft. between supports. A connection to rigid duct or equipment may be considered a support joint.
   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 must not exceed the maximum spacing in accordance with manufacturer's written installation instructions.
   4. Vertically installed ducts must 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. Centrifugal roof ventilators.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on sea level.
B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Dampers, including housings, linkages, and operators.
   6. Roof curbs.
   7. Fan speed controllers.
B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
D. Field quality control reports.
E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.
F. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.

G. Delegated Design Submittals: For roof mounted exhaust fan supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include design calculations for selecting wind restraints.
   2. Wind-Restraint Details: Wind-detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   4. Wind Performance: Roof mounted exhaust fans shall withstand the effects of wind determined in accordance with ASCE/SEI 7.

H. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Wind Performance: Roof mounted exhaust fans shall withstand the effects of wind determined in accordance with ASCE/SEI 7.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

A. Coordinate size and location of structural steel support members.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of power ventilators and associated components that fail in materials or workmanship within manufacturer’s standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Performance: Roof mounted exhaust fans shall withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and wind restraints.
C. Wind-Restraint Performance:
   1. See Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment" for requirements.

2.2 CENTRIFUGAL ROOF VENTILATORS
A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to,
   1. Carnes Company.
   2. Greenheck Fan Corporation.
   3. Loren Cook Company.
   4. PennBarry.
B. 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 and grease collector.
   2. Hinged Subbase: Galvanized steel hinged arrangement permitting service and maintenance.
C. Fan Wheels: Aluminum hub and wheel with backward inclined blades.
D. Belt Drives:
   1. Resiliently mounted to housing.
   2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
   3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
   4. Pulleys: Cast iron, adjustable-pitch motor pulley.
   5. Fan and motor isolated from exhaust airstream.
E. Accessories:
   1. Refer to schedules on drawings.
F. Capacities and Characteristics:
   1. Refer to schedules on drawings.

2.3 MOTORS
A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section, "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL
A. Certify sound power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.
B. Support units using spring isolators having a static deflection of 1 inch. Vibration and seismic control devices are specified in Division 23 Section, "Vibration and Seismic Controls for HVAC Piping and Equipment."
C. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. See Division 07 Section, "Roof Accessories" for installation of roof curbs.
D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration control devices are specified in Division 23 Section, "Vibration and Seismic Controls for HVAC Piping and Equipment."
E. Install units with clearances for service and maintenance.
F. Label units according to requirements specified in Division 23 Section, "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section, "Air Duct Accessories."
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Ground equipment according to Division 26 Section, "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Division 26 Section, "Low Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
    1. Verify that shipping, blocking, and bracing are removed.
    2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal overload protection is installed in motors, starters, and disconnect switches.
    3. Verify that cleaning and adjusting are complete.
    4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system.
    5. Adjust damper linkages for proper damper operation.
    6. Verify lubrication for bearings and other moving parts.

7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature control operators.
10. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust belt tension.
C. Comply with requirements in Division 23 Section, "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
D. Replace fan and motor pulleys as required to achieve design airflow.
E. Lubricate bearings.

3.5 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

3.7 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 233423

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Modulating, single-duct air terminal units.
   2. Casing liner.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, indicating 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 air terminal units to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Instructions for resetting minimum and maximum air volumes.
      b. Instructions for adjusting software set points.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of air terminal units and associated components that fail in materials or workmanship within manufacturer's standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.
B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to,
   1. Titus.
   2. Nailor.
   3. Krueger.
   4. Approved equal.
B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
C. Casing: Minimum 22-gauge- thick galvanized steel.
   1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Flexible Elastomeric" Paragraph.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
D. Volume Damper: Heavy gauge galvanized steel with peripheral gasket and self-lubricating bearings. Shaft shall be permanently and clearly marked on the end to indicate damper position. The damper shall incorporate a mechanical stop to prevent overstroking and a synthetic seal to limit close-off leakage.
   1. Maximum Damper Leakage: AHRI 880 rated, 1 percent of nominal airflow at 3-inch wg inlet static pressure.
   2. Actuators shall be capable of supplying at least 35-inch pounds of torque to the damper shaft and shall be mounted externally for service access.
E. Velocity Sensors: Multipoint array with velocity inlet sensors.
F. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless steel, machine-staked terminals secured with stainless steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Stage(s): Two.
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
4. Nickel chrome 80/20 heating elements.
5. Airflow switch for proof of airflow.
6. Fan interlock contacts.
7. Fuses in terminal box for overcurrent protection (for coils of more than 48 A).
8. Pneumatic-electric switches and relays.
9. Magnetic contactor for each step of control (for three-phase coils).

G. Direct Digital Controls:
1. Terminal Unit Controller to be provided Controls Contractor.

H. Control Sequence: See Section 230993 "Sequence of Operations for HVAC Controls" for control sequences.

2.3 CASING LINER

A. Casing Liner, Flexible Elastomeric: Flexible elastomeric duct liner fabricated of preformed, cellular, 1-1/2 pound density, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Minimum Thickness: 1/2 inch.
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 or Mechanical Fastening: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.4 SOURCE QUALITY CONTROL

A. AHRI 880 Certification: Test, rate, and label assembled air terminal units in accordance with AHRI 880.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.
B. Install air terminal units according to NFPA 90A.
C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 DUCTWORK CONNECTIONS

A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
B. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.6 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. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
   3. Verify that controls and control enclosure are accessible.
   4. Verify that control connections are complete.
   5. Verify that nameplate and identification tag are visible.
   6. Verify that controls respond to inputs as specified.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.7 ADJUSTING

A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Air terminal unit will be considered defective if it does not pass tests and inspections.
C. 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 air terminal units.

3.10 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

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. Square ceiling diffusers.
   2. Adjustable bar registers and grilles.
   3. Fixed face registers and grilles.

B. Related Sections:
   1. Division 23 Section, "Air Duct Accessories" for fire, smoke and combination fire/smoke and volume control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
   3. Manufacturer’s standard and custom color charts for finish selection, color selection by architect.

B. 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.

C. Samples for Verification: Air inlets and outlets to verify color selected.

D. Source quality control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Square Ceiling Diffusers (CD-A):
   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. Anemostat Products; a Mestek company.
      b. Carnes.
      c. Hart & Cooley Inc.

d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey.

2. Devices shall be specifically designed for variable air volume flows.
3. Material: 24 gauge steel, with one piece precision die-stamped cones.
4. Finish: Color as selected by architect from manufacturer's full range of standard and custom colors/finishes.
5. Face Size: Refer to schedule on drawings.
6. Face Style: Three cone.
7. Mounting: T-bar.
8. Pattern: Fixed.
9. Dampers: Radial opposed blade.

2.2 REGISTERS AND GRILLES

A. Fixed Face Registers and Grilles (ER-A and RR-A):
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. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
2. Material: Steel with 1-1/4" wide border on all sides and a minimum border gauge of 20. Corners shall be assembled with full penetration resistance welds. Screw holes shall be countersunk. Blades shall have a minimum gauge of 20 with a fixed deflection of 45 degrees.
3. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
4. Face Arrangement: Aeroblade blades with ¾" blade spacing. Blades shall be parallel to the long dimension.
5. Damper Type (Registers Only): Adjustable opposed blade, heavy gauge steel.

B. Heavy Duty Fixed Face Registers and Grilles (RR-B):
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. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.

h. Tuttle & Bailey.

2. Material: Steel with 1-1/4" border width on all side and a minimum border gauge thickness of 16, bars shall be 14-gauge steel. Bars shall be reinforced by perpendicular, steel support bars spaced on 6-inch maximum centers. ½-inch bar spacing and 38 degree fixed deflection bars parallel to the short dimension. Corners shall be assembled with full penetration resistance welds. Screw holes shall be countersunk.
3. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
4. Damper Type (Registers Only): Adjustable opposed blade, heavy gauge steel.

C. Adjustable Bar Register (SR-A):
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. Anemostat Products; a Mestek company.
b. Carnes.
c. Hart & Cooley Inc.
d. Krueger.
e. METALAIRE, Inc.
f. Nailor Industries Inc.
g. Price Industries.
h. Titus.
i. Tuttle & Bailey.
2. Material: Minimum 20-gauge, 1-1/4" inch wide steel border. Blades shall be constructed of heavy duty aluminum and airfoil contoured. Blades shall be solid. Corners shall be assembled with full penetration resistance welds. Screw holes shall be countersunk.
3. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
4. Face Blade Arrangement: Single deflection, individually adjustable blades. Blades parallel to the long dimension. Blades shall be spaced ¾-inch apart. Blades shall extend completely through the side frame on each side.
5. Damper Type: Adjustable opposed blade, heavy gauge steel.

2.3 SOURCE QUALITY CONTROL
A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install diffusers, registers, and grilles level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve

design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 233716 - FABRIC AIR-DISTRIBUTION DEVICES

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 continuous, tubular, fabric air-distribution devices.

1.3 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.
B. Shop Drawings: For fabric air-distribution devices.
   1. Include plans, elevations, sections, and suspension and attachment details.
C. Samples for Initial Selection: For diffusers with factory-applied color finishes.
D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected.
E. Diffuser Schedule: Use same designations indicated on Drawings. Indicate room location, quantity, model number, size, and accessories furnished.

1.4 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. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. FabricAir Inc.
   2. Prihoda North America.
   3. DuctSox Corporation.

2.2 PERFORMANCE REQUIREMENTS

A. Continuous tubular diffuser materials shall be listed and labeled as complying with UL 2518 and NFPA 90A.
B. Air permeability of fabric will comply with ASTM D737.

2.3 CONTINUOUS TUBULAR DIFFUSERS

A. Description:
   1. Fabric: Woven anti-microbial polyester.
   2. Shape: Round.
   3. Air-Outlet Configuration: Circumferential hole pattern with diffusion-holes along the length of the diffusion device.
   4. Color: To be selected by architect.
   5. Refer to drawings for more information.

B. Duct Connection Type: Round radial securing clips and zipper.

C. Accessories:
   1. Quick-connect joint.
   2. Snap hooks.
   3. Cleanout zipper.
   4. Condensate drain.
   5. Fabric damper.
   6. End cap.
   7. Draw cords.
   8. Removable support hoops.
   9. Elbows.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet 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. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

END OF SECTION 233716

SECTION 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Installation of owner-furnished equipment by Mechanical Contractor, refer to Section 011000 for additional information regarding owner-furnished equipment.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air handling units (rooftop units) with the following components and accessories. This equipment shall be owner-furnished, refer to Section 011000 for actual product information and components to be provided.
   1. Direct-expansion cooling.
   2. Hot-gas by-pass.
   3. Hot-gas reheat.
   4. Gas furnace.
   5. Economizer outdoor- and return-air damper section.
   6. Integral, space temperature controls.
   7. Roof curbs.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.
B. ECM: Electrically commutated motor.
C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air conditioning, heating, or ventilating apparatus.
G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air conditioning, heating, or ventilating apparatus.

1.4 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
C. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Structural members to which RTUs will be attached.
   2. Roof openings
   3. Roof curbs and flashing.
D. Field quality control test reports.
E. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.
F. Warranty: Special warranty specified in this section.
G. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC.
H. Delegated Design Submittal: For RTU supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include design calculations for selecting vibration isolators wind restraints, and for designing vibration isolation bases.
   2. Wind-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
I. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. ARI Compliance:
   1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.
B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air Conditioning."
D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
E. ASHRAE 15, NFPA 90A, and NFPA 90B.
F. UL Compliance: Comply with UL 1995.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Compressor Parts: 5 years from date of Substantial Completion.
   2. Warranty Period for Gas Furnace Heat Exchanger Parts: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Performance: Air-handling units shall withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
C. Wind-Restraint Performance:
   1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 MANUFACTURERS

A. Furnished by the Owner, refer to Section 011000 for product information and components.

2.3 CASING

A. LEED-NC Prerequisite EQ 1 requires compliance with ASHRAE 62.1-2004. ASHRAE 62.1-2004, Section 5.14 - "Access for Inspection, Cleaning, and Maintenance," sets requirements for equipment access. If applying for LEED certification, comply with requirements in ASHRAE 62.1-2004.
B. 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.
C. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: Minimum 0.052 inch thick.

D. Inner Casing Fabrication Requirements:
1. Inside Casing: Galvanized steel, minimum 0.034 inch thick.

E. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

F. Condensate Drain Pans: Formed sections of stainless steel sheet, that shall extend beyond the leaving side of the coil. Drain pan shall have a minimum slope of 1/8” per foot. Slope of drain pan shall be in two directions and comply with ASHRAE Standard 62.1.
1. Drain Connections: Threaded nipple both sides of drain pan.

G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.4 FANS

A. Direct-Driven Supply-Air Fans: Single width, single inlet airfoil, centrifugal. Class II construction. Solid steel fan shaft. Entire assembly shall be isolated from the fan bulkhead with a flexible collar. Assembly shall be statically and dynamically balanced at factory. Fan motor shall be total enclosed EC motor and shall include thermal overload protection. Fan shall be capable of airflow modulation from 30% to 100%.

B. Direct-Driven Exhaust Fan: Single width, single inlet airfoil, centrifugal. Class II construction. Fan motor shall be total enclosed EC motor and shall include thermal overload protection. Speed controlled by the rooftop unit controller. Motors shall be premium efficiency with phase failure protection. The unit controller shall provide proportional control of the exhaust fan from 25% to 100% supply fan designed airflow to maintain building pressure set-point.

C. Condenser-Coil Fan: Direct drive, propeller or axial type designed for low tip speed, mounted on shaft of permanently lubricated motor. Motors (RTU-1) shall be heavy-duty, inherently protected, non-reversing type with integral rain shield. Fan motors (RTU-3, 4, and 5) shall be ECM type for proportional control.

D. Fan Motors: Comply with requirements in Division 23 Section, "Common Motor Requirements for HVAC Equipment."

2.5 COILS

A. Supply-Air Refrigerant Coil:
1. Fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be multi-row, staggered tube design. All coils shall be factory leak tested with high pressure air under water. RTU-1 shall have two independent refrigerant circuits.
2. Coil Split: Interlaced.
3. Condensate Drain Pan: Stainless formed with pitch and drain connections complying with ASHRAE 62.1-2004.

B. Outdoor-Air Refrigerant Coil:

1. All aluminum design, micro-channel tube with brazed aluminum fins. All coils shall be factory leak tested with high pressure air under water.
2. Condenser coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating.

C. Hot Gas Reheat Coil:
1. All aluminum design, micro-channel tube with brazed aluminum fins. All coils shall be factory leak tested with high pressure air under water.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Compressor: Scroll compressors, one of which shall be an inverter compressor providing proportional control. Unit controller shall control speed of the compressor to maintain discharge air temperature. The inverter compressor shall have a separate oil pump and an oil separator. Compressors shall be isolated with resilient rubber isolators.

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 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.

2.7 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2. Refer to equipment schedules for filter requirements.

2.8 HEAT PUMP HEATING

A. The evaporator coil, condenser coil, compressors and refrigerant coil circuit shall be designed for heat pump operation. The refrigerant circuit shall contain a 4-way reversing valve for the heat pump operation. The outdoor coil shall have an electronic expansion valve to control the refrigerant flow. The unit controller shall modulate the expansion valve to maintain compressor operation within the compressor operational envelope.

B. The refrigerant system shall have a pump-down cycle.

C. The unit shall have a natural gas furnace for hybrid heating. When the heat pump operation cannot maintain the discharge air temperature set-point the natural gas furnace shall temper the airstream to the discharge air temperature set-point.

2.9 GAS FURNACE

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54. Installed downstream of the supply air fan in the heat section. The heating module shall be complete with furnace controller and control valve capable of modulating operation. Heating module shall be tubular design with in-shot gas burners and an induced draft fan.
   1. CSA Approval: Designed and certified by and bearing label of CSA.
B. Burners:
   1. Fuel: Natural gas.
   2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
C. Heat Exchanger and Drain Pan: Stainless steel.
D. Safety Controls:
   1. Gas Control Valve: Modulating.
   2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
   3. Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold operation.
   4. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

2.10 DAMPERS

A. Units shall include an outdoor air economizer section. The 0 to 100% outside air economizer section shall include outdoor, return and exhaust air dampers. Economizer operation shall be integral to the mechanical cooling. The outside air and return dampers shall be sized to handle 100% of the supply air volume.
   1. Damper Motor: Control of dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type.
   2. Relief-Air Damper: Barometric exhaust damper with bird screen. Damper blades shall be lined with vinyl gasketing on contact edges.
   3. Outdoor air hood, factory installed and constructed from galvanized steel. Hood shall include moisture eliminator filters to drain water away from the entering air stream.
   4. Outside air and return air dampers shall be parallel blade design. Gasketed with side seals to provide an air leakage rate of 1.5 CFM / Square Foot of damper area at 1” differential pressure according with testing defined in AMCA 500.
   5. Provide factory installed and tested, outdoor air monitor that controls outdoor air +/- 15% accuracy down to 40 CFM per ton.

2.11 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 ENERGY RECOVERY

A. The rooftop unit shall be provided with an AHRI certified rotary wheel air-to-air heat exchanger in a cassette frame complete with seals, drive motor and drive belt. The energy recovery wheel shall be an integral part of the rooftop unit with unitary construction and does not require field assembly. Bolt-on energy recovery units that require field assembly and section to section gasketing and sealing are not acceptable.

B. The wheel capacity, air pressure drop and effectiveness shall be AHRI certified per AHRI Standard 1060. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Heat Exchangers For Energy Recovery Ventilation Equipment.

C. The rooftop unit shall be designed with a track so the entire energy recovery wheel cassette can slide out from the rooftop unit to facilitate cleaning.

D. The unit shall have 2" Merv 7 filters for the outdoor air before the wheel to help keep the wheel clean and reduce maintenance. Filter access shall be by a hinged access door with ¼ turn latches.

E. The matrix design shall have channels to reduce cross contamination between the outdoor air and the exhaust air. The layers shall be effectively captured in aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belt(s) of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.

F. The total energy recovery wheel shall be coated with silica gel desiccant permanently bonded without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

G. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning.

H. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel. Wheels shall be connected to the shaft by means of taper lock hubs.

I. The exhaust air fan shall be a direct drive SWSI plenum fan. The exhaust fan shall be sized for the airflow requirements per the construction schedule. The unit controller shall control the exhaust fan to maintain building pressure. A VFD shall be provided for the exhaust fan motor or the exhaust fan motor shall be an ECM motor.The rooftop unit shall have single point electrical power connection and shall be ETL listed.

J. The control of the energy recovery wheel shall be an integral part of the rooftop unit’s DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed at the rooftop units DDC

controller LCD display. All of these temperatures shall be made available through the BACnet interface.

K. The rooftop unit DDC controller shall provide frost control for the energy recovery wheel. When a frost condition is encountered the unit controller shall (stop, slow down) the wheel. When in the frost control mode the wheel shall be jogged periodically and not be allowed to stay in the stationary position.

2.13 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section, "Instrumentation and Control for HVAC."

B. Variable Air Volume Control: The unit controller shall proportionally control the ECM motor on the supply fan. Unit manufacturer shall install all power and control wiring.

2.14 ACCESSORIES

A. Refer to schedules on drawings.

2.15 ROOF CURBS

A. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    a. Materials: ASTM C 1071, Type I or II.
    b. Thickness: 1-1/2 inches.
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
    a. Liner Adhesive: Comply with ASTM C 916, Type I.
    b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
    c. Liner materials applied in this location shall have air stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
    d. Liner Adhesive: Comply with ASTM C 916, Type I.

C. Curb Height: 24 inches.

2.16 CAPACITIES AND CHARACTERISTICS

A. Refer to schedules on drawings.

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. Roof Curb: Turnover roof curb to general contractor for installation. Install RTUs on curbs and coordinate roof penetrations and flashing with general contractor. Secure RTUs to upper curb rail.
B. Unit Support: Install unit level on roof curb.

3.3 CONNECTIONS

A. Coordinate piping and duct installations and specialty arrangements with schematics on Drawings and with requirements specified in piping and duct systems. If Drawings are explicit enough, these requirements may be reduced or omitted.
B. Verify condensate drainage requirements of authorities having jurisdiction.
C. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
D. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
    1. Install ducts to termination at top of roof curb.
    2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb. Coordinate with general contractor.
    3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section, "Air Duct Accessories."
    4. Install return-air duct continuously through roof structure.

3.4 FIELD QUALITY CONTROL

A. Furnished by Owner, refer to Section 011000 for more information.

3.5 STARTUP SERVICE

A. Furnished by Owner, refer to Section 011000 for more information.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 CLEANING AND ADJUSTING

A. After completing system installation and testing, adjusting, and balancing RTU and air distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

A. Furnished by Owner, refer to Section 011000 for more information.

3.8 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS. This shall be provided by both the Owner's equipment vendor and the Mechanical Contractor.

B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 237413

SECTION 238126 - SPLIT-SYSTEM AIR CONDITIONERS

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. Installation of owner-furnished equipment by Mechanical Contractor, refer to Section 011000 for additional information regarding owner-furnished equipment.

1.2 SUMMARY

A. Section includes split-system air conditioning and heat pump units consisting of separate evaporator fan and compressor-condenser components. This equipment shall be owner-furnished, refer to Section 011000 for actual product information and components to be provided.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Field quality control reports.

E. Operation and Maintenance Data: For split-system air conditioning units to include in emergency, operation, and maintenance manuals.

F. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.

G. Delegated Design Submittal: For roof mounted outdoor unit supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Include design calculations for selecting vibration isolators wind restraints.
   2. Wind-Restraint Details: Detail fabrication and attachment of wind restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
   3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
   4. Wind performance: Roof mounted outdoor units shall withstand the effects of wind determined in accordance with ASCE/SEI 7.

H. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
1. Warranty Period:
a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: One year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Filters: One set(s) for each air-handling unit.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Performance: Outdoor units shall withstand the effects of wind determined in accordance with to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and wind restraints, including comprehensive engineering analysis.
C. Wind-Restraint Performance:
1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 MANUFACTURERS
A. Furnished by the Owner, refer to Section 011000 for product information and components.

2.3 INDOOR UNITS 5 TONS OR LESS
A. Indoor, Recessed, Ceiling-Mounted Units:
1. Description: Factory-assembled and tested complete unit with components, piping, wiring and controls required for mating to ductwork, piping, power and controls field connections.
2. Cabinet:
a. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
b. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
c. Mounting: Manufacturer-designed provisions for field installation.
d. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
3. DX Coil Assembly:
a. Coil Casing: Aluminum, galvanized, or stainless steel.
b. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
c. Coil Tubes: Copper, of diameter and thickness required by performance.
d. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
e. Internal Tubing: Copper tubing with brazed joints.
f. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
g. Field Piping Connections: Manufacturer's standard.
h. Factory Charge: Dehydrated air or nitrogen.
i. Testing: Factory pressure tested and verified to be without leaks.
4. Drain Assembly:
a. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
b. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
c. Field Piping Connection: Non-ferrous material with threaded NPT.
5. Fan and Motor Assembly:
a. Fan(s):
1) Direct-drive arrangement.
2) Single or multiple fans connected to a common motor shaft and driven by a single motor.

3) Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
4) Wheels statically and dynamically balanced.
5) Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
6) Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
7) 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.
8) Vibration Control: Integral isolation to dampen vibration transmission.

6. Filter Assembly:
   a. Access: Bottom, to accommodate filter replacement without the need for tools.
   b. Media:
      1) Washable: Manufacturer’s standard filter with antimicrobial treatment.
7. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.
   a. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
   b. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
8. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.
9. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.
10. Unit Accessories:
    a. Refer to equipment schedule on drawings for additional requirements.
11. Unit Controls:
    a. Enclosure: Manufacturer’s standard, suitable for indoor locations.
    b. Factory-Installed Controller: Configurable digital control.
    c. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification, drain assembly high water level safety shutdown and notification, run test switch.
    d. Communication: Network communication with other indoor units and outdoor unit(s).
    e. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
    f. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
12. Unit Electrical:
    a. Enclosure: Manufacturer's standard, and suitable for indoor locations.
    b. Field Connection: Single point connection to power entire unit and integral controls.
    c. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.
    d. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
    e. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

f. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

B. Wall-Mounted, Evaporator Fan Components:
1. Cabinet: Enameled steel with removable panels on front and ends, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
3. Fan: Direct drive, centrifugal.
4. Fan Motors:
a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section, "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Enclosure Type: Totally enclosed, fan cooled.
d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
f. Mount unit-mounted disconnect switches on interior of unit.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
6. Condensate Drain Pans:
a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends), and to direct water toward drain connection.
b. Single-wall, galvanized steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
7. Air Filtration Section:
a. General Requirements for Air Filtration Section:
1) Comply with NFPA 90A.
2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

2.4 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual reset high pressure switch and automatic reset low pressure switch.
c. Refrigerant Charge: R-454B.

d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat Pump Components: Reversing valve and low temperature air cutoff thermostat.
4. Fan: Aluminum propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal overload protection.
6. Mounting Base: Polyethylene.

2.5 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
B. Refer to equipment schedule on drawings for additional requirements.

2.6 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.
B. Install evaporator fan components using manufacturer's standard mounting devices securely fastened to building structure.
C. Install roof-mounted, compressor-condenser on equipment mounting pad. Anchor units to supports with removable, cadmium-plated fasteners.
D. Install compressor-condenser on neoprene vibration isolation pads. See Division 23 Section, "Vibration and Seismic Controls for HVAC Piping and Equipment."
E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

A. Furnished by Owner, refer to Section 011000 for more information.

3.4 STARTUP SERVICE

A. Furnished by Owner, refer to Section 011000 for more information.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.5 DEMONSTRATION

A. Furnished by Owner, refer to Section 011000 for more information.

3.6 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS. This shall be provided by both the Owner's equipment vendor and the Mechanical Contractor.

B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 238126

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 electric, baseboard 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. Include enclosure joints, corner pieces, access doors, and other accessories.
   6. 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. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.

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.

1.5 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of finned-tube radiation heaters and associated components that fail in materials or

workmanship within manufacturer's standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRIC BASEBOARD PANEL RADIATION HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Runtal.
   2. Approved equal.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021. Electric panel radiator (baseboard style). Refer to schedule on drawings for more information.
   1. 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. Heating Elements:
   1. Volts: 208.
   2. Phase: Single.
   3. Hertz: 60.
   4. Heat Output: 500 BTUH/LF.

D. Enclosures: Welded steel construction.
   1. End panel.
   2. End caps.
   3. Inside and outside corners.
   4. Joiner pieces to snap together.
   5. Enclosure Height: 10-1/8 inches.
   6. Enclosure Depth: 2-1/4 inches.
   7. Finish: Powder coat finish in manufacturer's standard or custom color as selected by Architect.
   8. Element Brackets: Primed and painted steel to support front panel and element.

E. Unit Controls: Remote line-voltage thermostat.

F. Accessories:
   1. Filler sections without a heating element matching the adjacent enclosure.
   2. Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

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 electrical 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 enclosure continuously from wall to wall.
E. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

3.3 CONNECTIONS

A. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
   2. 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.

3.5 STARTUP SERVICE

A. Perform startup service.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

3.7 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 238236

SECTION 238239 - 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:
   1. Cabinet unit heaters with centrifugal fans and electric-resistance heating coils.
   2. Wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. CWP: Cold working pressure.
C. PTFE: Polytetrafluoroethylene plastic.
D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Plans, elevations, sections, and details.
   2. Location and size of each field connection.
   3. Details of anchorages and attachments to structure and to supported equipment.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
   5. Location and arrangement of piping valves and specialties.
   6. Location and arrangement of integral controls.
   7. Wiring Diagrams: Power, signal, and control wiring.
C. 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, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which unit heaters will be attached.
   3. Method of attaching hangers to building structure.
   4. Size and location of initial access modules for acoustical tile.
   5. Items penetrating finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

F. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

G. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of unit heaters and associated components that fail in materials or workmanship within manufacturer’s standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Berko.
2. Marley.
3. Q-Mark.
4. Modine.
5. Indeeco.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be erosion-resistant coating to prevent erosion of glass fibers.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.

3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Cabinet: Steel with baked-enamel finish with manufacturer's custom paint, in color selected by Architect.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing 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.

E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Washable Foam: 70 percent arrestance and 3 MERV.
2. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
3. Pleated: 90 percent arrestance and 7 MERV.

F. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in a 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.

G. 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 Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

H. Basic unit controls: Unit mounted thermostat.

I. Electrical Connection: Factory wire motors and controls for a single field connection.

J. Capacities and Characteristics:
1. Refer to schedules on drawings.

2.2 WALL AND CEILING HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Berko Electric Heating; a division of Marley Engineered Products.
2. Chromalox, Inc.; a division of Emerson Electric Company.
3. Indeeco.

4. Marley Electric Heating; a division of Marley Engineered Products.
5. QMark Electric Heating; a division of Marley Engineered Products.

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:
1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.
1. Motor: Permanently lubricated. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Controls: Unit-mounted thermostat.

H. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

I. Capacities and Characteristics:
1. Refer to equipment schedule on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

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 Division 07 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Install wall-mounting 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.

F. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.
B. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. 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 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. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 STARTUP SERVICE

A. Perform startup service.
    1. Complete installation and startup checks according to manufacturer's written instructions.
B. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

3.8 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 230800, COMMISSIONING OF HVAC SYSTEMS.
B. Components provided under this section of the specification will be tested as part of a larger system.

END OF SECTION 238239

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

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. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Grout.
   5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section, "Access Doors and Frames."
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section, "Penetration Firestopping".

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS
A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.

   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT
A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION
A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Extend sleeves installed in floors 6 inches above finished floor level.
G. Size pipe sleeves to provide [1/4-inch] annular clear space between sleeve and raceway or cable, unless indicated otherwise.
H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
    1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section, "Joint Sealants.".
J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section, "Penetration Firestopping."
K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
M. Underground, Exterior-Wall Penetrations: Install cast iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.
B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

Firestopping materials and installation requirements are specified in Division 07 Section, "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519 - LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.
C. Home run: Branch circuit wiring extended from the source of power to either the first electrical device or to a central location of the associated circuit and acts as a distribution point to the devices indicated to be powered by the source.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Qualification Data: For testing agency.
C. Field quality control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

E. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section, "Penetration Firestopping."

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Stranded.

B. Branch Circuits: Copper. Stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.
C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
D. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
E. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
   1. Home run: Type THHN-THWN. Single conductors in raceway.
   2. Between devices wired to same source branch circuit: Type THHN-THWN. Metal-clad cable, Type MC.
F. Branch conductor above accessible ceilings:
   1. Home Run: Type THHN-THWN. Single conductors in raceway.
   2. Between devices wired to same source branch circuit: Type THHN-THWN. Metal-clad cable, Type MC.

3.3 INSTALLATION OF CONDUCTORS AND CABLES
A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
E. Support cables according to Division 26 Section, "Hangers and Supports for Electrical Systems."
F. Identify and color code conductors and cables according to Division 26 Section, "Identification 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 and UL 486B.
B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
C. Delete subparagraph below unless aluminum conductors are specified.
D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIELD QUALITY CONTROL
A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
B. Perform tests and inspections and prepare test reports.
C. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test Reports: Prepare a written report to record the following:
    1. Test procedures used.
    2. Test results that comply with requirements.
    3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260526 -GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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: Grounding systems and equipment.

1.3 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
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 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
B. Bare Copper Conductors:
   1. Solid Conductors: ASTM B 3.
   2. Stranded Conductors: ASTM B 8.
   3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
   4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 6 by 24 inches, 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. Lexan or PVC, impulse tested at 5000 V.

2.2 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. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.
C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

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. 2/0 AWG minimum.
   1. Bury at least 24 inches below grade.
C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus on insulated spacers 2 inches minimum from wall, 84 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 to specified height above floor; connect to horizontal bus.
D. 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.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.
B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway runs.
   7. Armored and metal-clad cable runs.
   8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
E. Metal 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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with 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. 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.

B. Grounding system will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.
D. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
E. 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 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
B. Related Sections include the following:
   1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Equipment supports.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Thomas & Betts Corporation.
      e. Unistrut; Tyco International, Ltd.
   3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   5. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   4. Toggle Bolts: All-steel springhead type.
   5. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as

used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquidtight flexible metal conduit.

G. LFNC: Liquidtight flexible nonmetallic conduit.

H. NBR: Acrylonitrile-butadiene rubber.

I. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. O-Z Gedney; a unit of General Signal.
4. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.
D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch, minimum.
E. EMT: ANSI C80.3.
F. FMC: Zinc-coated steel.
G. LFMC: Flexible steel conduit with PVC jacket.
H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Fittings for EMT: Steel, set-screw type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.
I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. CANTEX Inc.
   3. Lamson & Sessions; Carlon Electrical Products.
   4. RACO; a Hubbell Company.
   5. Thomas & Betts Corporation.
C. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
D. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.
B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.
C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
D. Wireway Covers: Screw-cover type.
E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Thomas & Betts Corporation.
      b. Walker Systems, Inc.; Wiremold Company (The).
      c. Wiremold Company (The); Electrical Sales Division.

B. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Hubbell Incorporated; Wiring Device-Kellems Division.
      b. Lamson & Sessions; Carlon Electrical Products.
      c. Panduit Corp.
      d. Walker Systems, Inc.; Wiremold Company (The).
      e. Wiremold Company (The); Electrical Sales Division.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. Erickson Electrical Equipment Company.
   3. Hoffman.
   4. O-Z/Gedney; a unit of General Signal.
   5. RACO; a Hubbell Company.
   6. Thomas & Betts Corporation.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: EMT.
   3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. 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.

B. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

G. 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.

H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

J. Flexible Conduit Connections: Use maximum of 48 inches of flexible conduit for recessed and semi recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

K. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
   1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches in nominal diameter.
   2. Install backfill as specified in Division 31 Section "Earth Moving." After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
   4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
      a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
      b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
   5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL 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. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   4. Underground-line warning tape.
   5. Warning labels and signs.
   6. Equipment identification labels.
   7. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with ANSI Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
B. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.

2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:
1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
B. Apply identification devices to surfaces that require finish after completing finish work.
C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
D. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.
B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
    1. Emergency Power.
    2. Power.
C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
    1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
        a. Color shall be factory applied for conductors up to No. 8 AWG, and field applied for conductors larger than No. 8 AWG.
        b. Colors for 208/120-V Circuits:
            1) Phase A: Black.
            2) Phase B: Red.
            3) Phase C: Blue.
        c. Colors for 480/277 V circuits:
            1) Phase A: Brown.
            2) Phase B: Orange.
            3) Phase C: Yellow.

D. Install instructional sign including the color code for grounded and ungrounded conductors using adhesive-film-type labels.
E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
H. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
      c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
      d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   2. Equipment to Be Labeled:
      a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Enclosed switches.
      e. Contactors.

END OF SECTION 260553

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 26.

B. This project will have selected building HVAC systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 230800 “Commissioning of HVAC”. A Commissioning Agent (CxA) appointed by and working directly for The School District will manage the commissioning process.

1.2 RELATED WORK

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

B. Division 23 “Commissioning of HVAC”.

1.3 SUMMARY

A. This Section includes requirements for commissioning all emergency and exit lighting, lighting control systems and general power systems and facility electrical systems, as they relate to the HVAC systems being commissioned.

1.4 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Provide all labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing.

B. Perform commissioning tests at the direction of the CxA.

C. Attend construction phase coordination meetings.

D. Provide information requested by the CxA for final commissioning documentation.

E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for all HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.
C. Provide test data, inspection reports, and certificates in Systems Manual.
D. The CxA will be appointed by and work directly for The School District.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:
   1. Process and schedule for completing construction checklists for emergency and exit lighting equipment, wiring and components to be verified and tested.
   2. Process and schedule for completing construction checklists for lighting controls equipment, wiring and components to be verified and tested.
   3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
   4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
   5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
   6. Test and inspection reports and certificates.
   7. Corrective action documents.

1.8 SUBMITTALS

A. Certificates of readiness.
B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
B. The CxA shall prepare detailed testing plans, procedures, and checklists for all systems to be commissioned as part of this project.

END OF SECTION 260800

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Indoor occupancy and vacancy sensors.
   2. Conductors and Cables
   3. Switchbox-Mounted Motion Sensors
   4. Electronic Time Switches

B. Related Sections include the following:
   1. Division 26 Section, "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing wiring for each system detailed in the ‘Lighting Control Room Schedule’.
   2. Device submittals shall be organized by ‘Note Number’ in ‘Lighting Control Room Schedule’.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Current Lighting, NX Lighting

2. Hubbell Lighting
3. Steinel Lighting Controls
4. Leviton Mfg. Company Inc.

B. General Description:
1. Wall or ceiling mounted, solid-state indoor occupancy and vacancy sensors.
2. Passive infrared (PIR), ultrasonic, or dual technology. Refer to drawings for specification.
3. Separate power pack
4. Hardwired connection to power pack
5. Operation:
   a. Vacancy Mode (Manual on/Automatic off): Turn lights on via local manual switch and off when space is unoccupied; with a time delay for turning lights off, adjustable over a maximum range of 1 to 20 minutes.
   b. Occupancy Mode (Automatic on/Automatic off): When local switch is close, turned lights on when space is occupied and off when space is unoccupied; with a time delay for turning lights off, adjustable over a maximum range of 1 to 20 minutes.
6. Sensor Output: Sensor is powered from the power pack.
7. Power pack: Contacts rate for 20A LED load at 120 and 277 V(ac). Sensor has 24 V(dc) Class 2 power source.
8. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 3/4-inch knockout in a standard electrical enclosure.
9. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
10. Bypass Switch: Override the on function in case of sensor failure.
11. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keep lighting off when selected lighting level is present.

C. PIR Type: Wall or ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch.

D. Ultrasonic Type: Wall or ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be 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.

F. Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
   1. Lighting control set point is based on the following two lighting conditions:
      a. When no daylight is present (target level).
      b. When significant daylight is present.
   2. System programming is done with hand-held, initial setup remote-control tool.

G. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate powerpack, to detect changes in indoor lighting levels that are perceived by the eye.

H. Power Pack: Digital controller capable of accepting multiple input with three outputs rated for 20A loads at 120 and 277V (ac). Sensor has 24V(dc) Class 2 power source.

2.2 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section, "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 Division 26 Section, "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 Division 26 Section, "Low-Voltage Electrical Power Conductors and Cables."

2.3 SWITCHBOX-MOUNTED MOTION SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Current Lighting, NX Lighting
   2. Steinel Lighting Controls
   3. Hubbell Lighting
   4. Leviton Mfg. Company Inc.

B. General Requirements for Sensors: Automatic wall switch motion sensor with manual on-off switch, suitable for mounting in a single hang switchbox using hardwired connection.

C. Operation:
   a. Vacancy Mode (Manual on/Automatic off): Turn lights on via local manual switch and off when space is unoccupied; with a time delay for turning lights off, adjustable over a maximum range of 1 to 20 minutes.
   b. Occupancy Mode (Automatic on/Automatic off): When local switch is close, turned lights on when space is occupied and off when space is unoccupied; with a time delay for turning lights off, adjustable over a maximum range of 1 to 20 minutes.

2.4 ELECTRONIC TIME SWITCHES

A. Manufacturers: Subject to complance with requirements, provide products by one of the following:
   1. Intermatic, Inc.
   2. Lithonia Lighting
   3. Square D; Schneider Electric
   4. TORK

B. Electronic time switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
C. Program: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
D. Circuitry: Allow connection of photoelectric relay as substitute for on-off function of a program.
E. Astronomic Time: All channels

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION
A. 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.

3.2 WIRING INSTALLATION
A. Wiring Method: Comply with Division 26 Section, "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.3 IDENTIFICATION
A. Identify components and power and control wiring according to Division 26 Section, "Identification for Electrical Systems."
1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
B. Lighting control devices that fail tests and inspections are defective work.

3.5 ADJUSTING
A. Motion Sensor and Daylight Sensor Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION
A. Coordinate demonstration of products specified in this Section.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section, "Demonstration and Training."

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
C. Qualification Data: For testing agency.
D. Source quality control test reports.
E. Field quality control test reports.
F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. General Electric Company
   2. Hammond Co.; Matra Electric, Inc.
   3. Myers Power Products, Inc.
   4. Siemens Energy & Automation, Inc.
   5. Square D; Schneider Electric

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Aluminum.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section, "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.
K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
1. Complying with NEMA TP 1, Class 1 efficiency levels.
2. Tested according to NEMA TP 2.
L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.
M. Wall Brackets: Manufacturer's standard brackets.
N. Fungus Proofing: Permanent fungicidal treatment for coil and core.
O. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.
P. Enclosure: Ventilated, NEMA 250, Type 2.
1. Finish Color: Gray.

2.4 IDENTIFICATION DEVICES
A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section, "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL
A. Test and inspect transformers according to IEEE C57.12.91.
B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
D. Verify that ground connections are in place and requirements in Division 26 Section, "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
1. Brace wall-mounting transformers as specified in Division 26 Section, "Vibration and Seismic Controls for Electrical Systems.
B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section, "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section, "Grounding and Bonding for Electrical Systems."
B. Connect wiring according to Division 26 Section, "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
C. Perform tests and inspections and prepare test reports.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Tests and Inspections:
    1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
E. Remove and replace units that do not pass tests or inspections and retest as specified above.
F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
    1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
    2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
    3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.
B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
C. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section, "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
C. 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.
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. Comply with NEMA PB 1.
F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT 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.

1.8 COORDINATION

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.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

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

1.10 EXTRA MATERIALS

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 Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section, "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush and Surface-mounted 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.
2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. 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
6. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
7. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Incoming Mains Location: Coordinated with field installation requirements.

D. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated aluminum.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
2. Siemens Energy & Automation, Inc.
3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder 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: As indicated on the drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Overcurrent Protective Devices: Fused switches.

H. 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. External Control-Power Source: 120-V branch circuit.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.
B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
C. Mains: As indicated on the drawings
D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
E. 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. External Control-Power Source: 120-V branch circuit.
F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
G. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.
B. Some manufacturers offer shunt-trip operators for their fused switches; however, most do not recommend using this feature for providing ground-fault protection on switches rated 1000 A and above in panelboards; they recommend using MCCBs or switches specified in Division 26 Section "Switchboards." Consult manufacturers for availability and limitations if this feature is required.
C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
   1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section, "Fuses."
   2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
C. Comply with mounting and anchoring requirements specified in Division 26 Section, "Vibration and Seismic Controls for Electrical Systems."
D. Mount with highest circuit breaker a maximum of 6’6” above finished floor unless otherwise indicated on the drawings.
E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
G. Install filler plates in unused spaces.
H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
J. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section, "Identification for Electrical Systems."
B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section, "Identification for Electrical Systems."
D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section, "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
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 stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
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. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
B. Circuit changes made during load balancing may negate color-coding of phases and circuits. If load balancing proves undesirable or is to be performed by others, delete paragraph below.
C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

A. Temporary Heating: 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 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Twist-locking receptacles.
   3. Wall-box motion sensors.
   4. Snap switches.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
D. RFI: Radio-frequency interference.
E. TVSS: Transient voltage surge suppressor.
F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
C. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, tamper-resistant, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, tamper resistant. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

2.4 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration as indicated on the drawings, and UL 498.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.
B. Switches, 120/277 V, 20 A:

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: Cold-rolled steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in "wet locations."
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. NECA 1 referenced in paragraph below includes device mounting-height requirements. See "Product Selection and Application Considerations" Article in the Evaluations for device mounting heights in that standard.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
   2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
   3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
   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 all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
   2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
   3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
   4. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
   5. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
   6. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
   7. Tighten unused terminal screws on the device.
   8. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Tests for Convenience Receptacles:
   1. Line Voltage: Acceptable range is 105 to 132 V.
   2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
   3. Ground Impedance: Values of up to 2 ohms are acceptable.
   4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
   5. Using the test plug, verify that the device and its outlet box are securely mounted.
   6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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:
   1. Fusible switches.
   2. Nonfusible switches.
   3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Include evidence of NRTL listing for series rating of installed devices.
B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
D. Comply with NFPA 70.

1.6 PROJECT 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.

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 no fewer than seven 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.

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   4. Lugs: Mechanical type, suitable for number, size, and conductor material.
   5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, 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. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Hookstick Handle: Allows use of a hookstick to operate the handle.
   4. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES
A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 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.

3.2 INSTALLATION
A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
C. Install fuses in fusible devices.
D. Comply with NECA 1.

3.3 IDENTIFICATION
A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL
A. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. 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.

END OF SECTION 262816

SECTION 262933 - CONTROLLERS FOR FIRE PUMP DRIVERS

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. Full-service controllers.
   2. Controllers for diesel-drive fire pumps.
   3. Controllers for pressure-maintenance pumps.
   4. Enclosures.

B. Related Requirements:
   1. Section 260548 ‘Vibration and Seismic Controls for Electrical Systems’

1.3 DEFINITIONS

A. ECM: Electronic control module.
B. MCCB: Molded-case circuit breaker.
C. PID: Proportional integral derivative.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of product indicated.
   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. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Enclosure types and details for types other than NEMA 250, Type 2.
      c. Factory-installed devices.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of integrated unit.
      f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
      g. Specified modifications.
   4. Include diagrams for power, signal, alarm, control wiring, and pressure-sensing tubing.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of product indicated, from manufacturer.
B. Source quality-control reports.
C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fire-pump controllers and associated equipment from single source or producer.

1.7 WARRANTY

A. Manufacturer Warranty: Manufacturer agrees to repair or replace components of controllers for fire pump devices and associated components that fail in materials or workmanship within manufacturer's standard warranty period. Warranty period of 1 year shall begin from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 20.
B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory, and marked for intended location and application.

2.2 FULL-SERVICE CONTROLLERS

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. Aquarius Fluid Products, Inc.
   2. Eaton.
   3. Hubbell Electrical Solutions; Hubbell Incorporated.
   4. Joslyn Clark Corporation.
   5. Tornatech.
B. General Requirements for Full-Service Controllers:
   1. Comply with NFPA 20, UL 218 and UL 1008.
   2. Combined automatic and nonautomatic operation.
   3. Factory assembled, wired, and tested; continuous-duty rated.
C. Method of Starting:
   1. Pressure-switch actuated.
      a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
      b. System pressure recorder, electric ac driven, with spring backup.
      c. Programmable minimum-run-time relay to prevent short cycling.
      d. Programmable timer for weekly tests.
   2. Solid-State Controller: Reduced-voltage type.
   3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of electric or pressure actuators.
D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.
E. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.
F. Door-Mounted Operator Interface and Controls:
   1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.

2. Method of Control and Indication:
   a. Microprocessor-based logic controller, with multiline digital readout.
   b. 4.2” color touch screen with PLC Logic technology.
   c. LED alarm and status indicating lights.
3. Local and Remote Alarm and Status Indications:
   a. Controller power on.
   b. Motor running condition.
   c. Loss-of-line power.
   d. Line-power phase reversal.
   e. Line-power single-phase condition.
4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

G. Optional Features:
1. Extra Output Contacts:
   a. Additional auxiliary NO and NC contacts wired to indicate position of the power transfer switch and emergency source isolating disconnect switch.
2. Local alarm bell.
3. Operator Interface Communications Ports: USB, Ethernet, and TIA-485.

H. ATS:
1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means:
   a. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker must be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
6. Local and Remote Alarm and Status Indications:
   a. Normal source available.
   b. Alternate source available.
   c. In normal position.
   d. In alternate position.
   e. Isolating means open.
7. Audible alarm, with silence push button.
8. Nonautomatic (manual, nonelectric) means of transfer.
9. Engine test push button.
10. Start generator output contacts.
11. Timer for weekly generator tests.

2.3 CONTROLLERS FOR DIESEL-DRIVE FIRE 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. Aquarius Fluid Products, Inc.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Hubbell Incorporated; Hubbell Industrial Controls.

4. Joslyn Clark Corporation.
5. Tornatech.

B. General Requirements for Controllers:
1. Comply with NFPA 20 and UL 218.
2. Listed by an NRTL for diesel-engine driver for fire-pump service.
3. Combined automatic and nonautomatic operation.
4. Factory assembled, wired, and tested.

C. Method of Starting:
1. Pressure-switch actuated.
a. Water--pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.
2. Dual, redundant dc-voltage battery units, with automatic changeover.
3. Emergency Control: Bypasses automatic control circuits during manual starting and running.
4. Automatic engine start on loss of ac power to the controller.

D. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

E. Door-Mounted Operator Interface and Controls:
1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
a. Microprocessor-based logic controller, with multiline LCD readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.
3. Local Alarm and Status Indications:
a. Controller power on.
b. Engine-lubrication-system critically low oil pressure.
c. Engine-jacket coolant high temperature.
d. Engine fail-to-start.
e. Engine overspeed shutdown.
f. Low fuel level.
g. Missing or failed battery.
h. Battery charger failure.
i. System overpressure.
j. ECM selector switch in alternate ECM position.
k. Fuel injector malfunction.
4. Audible alarm.
5. Nonautomatic START and STOP push buttons or switches.

F. Battery Charger System:
1. Built-in, independent, dual battery chargers with automatic changeover; 12 V(dc) for lead-acid batteries.
2. Standard: UL 1236.

G. Optional Features:
1. Extra Output Contacts:
a. One each, Form C contacts for high and low fuel levels.

b. One NO contact for motor running condition.
2. Operator Interface Communications Ports: USB, Ethernet, and TIA-485.
3. Powered louver contacts.

2.4 CONTROLLERS FOR PRESSURE-MAINTENANCE 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. Aquarius Fluid Products, Inc.
   2. Eaton.
   3. Hubbell Electrical Solutions; Hubbell Incorporated.
   4. Joslyn Clark Corporation.
   5. Tornatech.
B. General Requirements for Pressure-Maintenance-Pump Controllers:
   1. Type: UL 508, factory-assembled, -wired, and -tested, across-the-line controller; for combined automatic and manual operation.
   2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
   3. Factory assembled, wired, and tested.
   4. Finish: Manufacturer's standard color paint.
C. Rate controller for scheduled horsepower and include the following:
   1. Fusible disconnect switch.
   2. Pressure switch.
   3. Hand-off-auto selector switch.
   4. Pilot light.
   5. Running period timer.

2.5 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.
   1. Indoor, Dry and Clean Locations: Type 2 (IEC IP11).
B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".
C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers in accordance with requirements in NFPA 20 and UL 218.
   1. Verification of Performance: Rate controllers in accordance with operation of functions and features specified.
B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONTROLLERS

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
B. Install controllers within sight of their respective drivers.
C. Connect controllers to their dedicated pressure-sensing lines.
D. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inch above finished floor, and bottom of enclosure not less than 12 inch above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
F. Comply with NEMA ICS 15.

3.3 INSTALLATION OF POWER WIRING

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 INSTALLATION OF CONTROL AND ALARM WIRING

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70 and Section 260519 “Low Voltage Electrical Power Conductors and Cables.”
B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 283111 "Digital, Addressable Fire-Alarm Systems."
C. Bundle, train, and support wiring in enclosures.
D. Connect remote manual and automatic activation devices where applicable.

3.5 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.
B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
    1. Inspect and Test Each Component:
        a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.

b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
c. Test continuity of each circuit.

2. Verify and Test Each Electric-Drive Controller:
   a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for motor, notify Engineer before starting the motor(s).
   b. Test each motor for proper phase rotation.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Representatives from manufacturers of fire-pump controllers and ATS must be present during acceptance tests and inspections in accordance with NFPA 20.
C. Acceptance tests and inspections must be witnessed by Construction Manager.
D. Acceptance Tests and Inspections:
   1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Construction Manager and authorities having jurisdiction.
   2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
   3. Engage manufacturer's factory-authorized service representative to be present during the testing.
   4. Perform field acceptance tests as outlined in NFPA 20.
E. Nonconforming Work:
   1. Controllers will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective units and retest.
F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks in accordance with manufacturer's written instructions.

3.8 ADJUSTING

A. Adjust controllers and battery charger systems to function smoothly and as recommended by manufacturer.
B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
D. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature in accordance with manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controllers.

END OF SECTION 262933

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes lightning protection for building structures.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Shop Drawings: Detailed scale drawings for air terminals, conductors and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how concealment requirements will be met, and NFPA 780 requirements for bonding of grounded and isolated metal bodies.
C. Product Data: Catalog sheets for all components to be installed.
D. Qualification Data: Provide documentation that system is in compliance with the requirements of a U.L. Master Label system.
E. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features (if applicable), including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
B. System Certificate:
   1. UL Master Label.
   2. LPI System Certificate.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and installer, and HVAC equipment installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I copper unless otherwise indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   a. East Coast Lightning Equipment Inc.
   b. ERICO International Corporation.
   c. Independent Protection Co.
   d. Preferred Lightning Protection.
   e. Robbins Lightning, Inc.
   f. Thompson Lightning Protection, Inc.
2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for adhesive mounting to single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

C. Main and Bonding Conductors: Copper, 32 strand, 17 gauge, 64,800 circular mils.

D. Ground Rods: Copper-clad 3/4 inch in diameter by 10 feet long.

E. Cable Holders: Adhesive or mechanical mount as appropriate. Secure conductors every 3 feet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.

C. Conceal all conductors, including but not necessarily limited to:

1. Down conductors.
2. Interior conductors.
3. Conductors within normal view of exterior locations at grade.

D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.

F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

3.2 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 264113

SECTION 265100 - INTERIOR LIGHTING

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. Interior lighting fixtures, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.
   4. Lighting fixture supports.

B. Related Sections:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, and occupancy sensors.

1.3 DEFINITIONS

A. BF: Ballast factor.
B. CCT: Correlated color temperature.
C. CRI: Color-rendering index.
D. HID: High-intensity discharge.
E. LER: Luminaire efficacy rating.
F. Lumen: Measured output of lamp and luminaire, or both.
G. Luminaire: Complete lighting fixture, including ballast housing if provided.
H. L.E.D.: Light Emitting Diode.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Energy-efficiency data.
   4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for LED's.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Installation instructions.

D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. 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.

F. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    a. Lens Thickness: At least 0.125 inch minimum for 2’ x 2’ and 2’ x 4’ fixtures unless otherwise indicated.
    b. UV stabilized.

G. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. 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.

2.2 LED LIGHT FIXTURES

A. General:

1. Listing: LED fixtures shall be UL listed or UL classified, CE certified and PSA marked. LED fixture and systems shall meet RoHS (Removal of Hazardous

Substances) directives. Manufacturer shall be able to provide supporting documentation testing results.

2. LED drivers shall include the following features, unless otherwise indicated:
   a. Minimum efficiency: 85% at full load.
   b. Minimum operating ambient temperature: -4 deg F.
   c. Input voltage: 120 - 277V (±10%) at 60 Hz.
   d. Integral short circuit, open circuit, and overload protection.
   e. Power factor: ≥ 0.95.
   f. Total harmonic distortion: ≤ 20%.
   g. Comply with FCC 47 CFR Part 15.
3. LED modules shall include the following features, unless otherwise indicated:
   a. Comply with IES LM-79 and LM-80 requirements.
   b. Minimum CRI 80 and color temperature 3000° K, unless otherwise specified in Lighting Fixture Schedule.
   c. Minimum rated life: 50,000 hours per IES L70.
   d. Light output lumens as indicated in the Lighting Fixture Schedule.

H. LED Downlights:
1. Housing, LED driver and LED module shall be products of the same manufacturer.

I. Heat: Fixture housings shall be designed to transfer heat from the LED board to the outside environment.

J. Fixtures for Wet and Damp Use: Fixtures themselves shall be sealed, rated and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.

K. Connections: All hardwired connections to LED fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

L. Burn-In-Time: All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.

M. Single Source Components: All LED fixtures and power/data supplies shall be provided by a single manufacturer to ensure compatibility. Manufacturer shall have at least three years of experience designing, selling and supporting intelligent LED systems.

2.3 EMERGENCY POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
1. Emergency Connection: Operate one lamp or driver continuously at an output of 1100 lumens or the lumen output rating of the fixture (whichever is less) each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture 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.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

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: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Lay-in Ceiling Lighting Fixtures Supports:

1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
2. Fixture Support: Provide fixture support independent of ceiling grid. Provide a minimum of 4 hanger wires for each 2’ x 4’ fixture, and a minimum of 2 wires for each 2’ x 2’ fixture.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4 inch metal channels spanning and secured to ceiling tees.
4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
3. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

3.4 STARTUP SERVICE

A. Burn in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent, compact fluorescent lamps, and LED fixtures intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Exterior luminaires.
   2. Poles and accessories.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.
B. CRI: Color-rendering index.
C. LED: Light emitting diode.
D. LER: Luminaire efficacy rating.
E. Luminaire: Complete lighting fixture, including ballast housing if provided.
F. Pole: Luminaire support structure, including tower used for large area illumination.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-6.
B. Ice Load: Load of 3 lbf/sq. ft. applied as stated in AASHTO LTS-6 Ice Load Map.
C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-6.
   1. Basic wind speed for calculating wind load for poles 50 feet high or less is 90 mph.
      a. Wind Importance Factor: 1.0.
      b. Minimum Design Life: 25 years.
      c. Velocity Conversion Factors: 1.0.

1.5 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
      a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
   6. Materials, dimensions, and finishes of poles.

7. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
8. Anchor bolts for poles.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-6 and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

D. Concrete Base: Include plans, sections, and calculations prepared and stamped by a licensed professional engineer certifying that bases are designed for indicated load requirements in AASHTO LTS-6 and that load imposed by luminaire and attachments has been included in design.

E. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Package poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
C. Metal Parts: Free of burrs and sharp corners and edges.
D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
F. 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. Designed to disconnect ballast when door opens.
G. Exposed Hardware Material: Stainless steel.
H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
J. 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.
K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
L. Luminaire Finish: Manufacturer's paint applied to factory-assembled and -tested luminaire before shipping. Color choice shall be from manufacturer’s full range of standard and custom colors.

2.2 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.
B. Material and specifications for each luminaire are as follows:
    1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
    2. Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night. This life rating must be conducted 40C ambient temperature.
    3. The rated operating temperature range shall be -40°C to +40°C.
    4. Each luminaire is capable of operating above 100°F [37°C], but not expected to comply with photometric requirements at elevated temperatures.
    5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.

6. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
7. Luminaire shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
8. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an equivalent standard from a nationally recognized testing laboratory.

C. Technical Requirements
1. Electrical
   a. Power Consumption: Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.
   b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
   c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.
   d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 10 percent.
   e. Surge Suppression: The luminaire onboard circuitry shall include fused surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 5 kA (minimum). SPD shall conform to UL 1449 depending of the components used in the design. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category C (standard). The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.
   f. Each Luminaire shall have integral UL Listed Class II power supplies. Class I power supplies will not be acceptable.
   g. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
   h. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
   i. Drivers shall have a Class A sound rating.
2. Photometric Requirements
   a. Optical Assemblies: LEDs shall be provided with discreet over optical elements to provide IESNA Type II, III, IV or V distributions. Additional distributions for spill light control shall be utilized when light trespass must be mitigated. Mitigation must take place without external shielding elements. Optical assemblies shall have a minimum efficiency of 85% regardless of distribution type. For Type II and Type III distributions street side efficiencies shall be a minimum of 80%. All LEDs and optical assemblies shall be mounted parallel to the ground. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.

b. Illuminance: The illuminance shall not decrease by more than 30% over the expected operating life. The measurements shall be calibrated to standard photopic calibrations.
c. Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) range of 4,000K to 4,500K. The color rendition index (CRI) shall be 70 or greater. Binning of LEDs shall conform to ANSI/NEMA SSL 3-2010.
d. Backlight-Uplight-Glare: The luminaire shall not allow more than 10 percent of the rated lumens to project above 80 degrees from vertical. The luminaire shall not allow more than 2.5 percent of the rated lumens to project above 90 degrees from vertical. Backlight and Glare ratings as per fixture schedule and calculated per IESNA TM-15.

3. Thermal Management
   a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
   b. The LED manufacturer's maximum thermal pad temperature for the expected life shall not be exceeded.
   c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
   d. The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.
   e. The heat sink material shall be aluminum.
4. Physical and Mechanical Requirements
   a. The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply for the luminaire shall be integral to the unit.
   b. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.
   c. Luminaires shall be capable of withstanding cyclical loading in (G = Acceleration of Gravity): a minimum peak acceleration level of 3.0 G peak-to-peak sinusoidal loading with the internal driver installed, for a minimum of 100,000 cycles without failure of any luminaire parts. Testing to be performed in three planes: a horizontal plane parallel to the direction of mounting, a horizontal plane perpendicular to the direction of mounting and the vertical plane.
   d. The housing shall be designed to prevent the buildup of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire, and carry dust and other accumulated debris away from the unit.
   e. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components.
   f. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.
   g. Door shall be hinged and secured to the housing in a manner to prevent its accidental opening.

h. The circuit board and power supply shall be contained inside the luminaire. Electrolytic capacitors used in the power supplies shall be rated for -40°F to 220°F (-40°C to +105°C), long life (> 5000 hours), and operated at no more than 70% of their rated voltage, and 70% of rated current.

5. Materials
   a. Housings shall be fabricated from materials that are designed to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.
   b. Each refractor or lens shall be made from UV inhibited high impact plastic such as acrylic and be resistant to scratching.
   c. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. The len(s) of the luminaire are excluded from this requirement

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-6.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 3 by 5 inches, with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Pre-cast, with anchor bolts to match pole-base flange.

2.4 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig ; one-piece construction up to 40 feet in height with access handhole in pole wall.
   1. Shape: Square, straight & round, straight.
   2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch handhole located at midpoint of pole with cover for access to internal welded attachment lug for electric cable support grip.

D. Grounding and Bonding Lugs: Welded 1/2-inch threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems,"

listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

E. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
   2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
   3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
      a. Color: As selected by Architect from manufacturer's full range.

2.4 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole. All poles shall be plumb, utilize shims at concrete base as necessary.
B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.
C. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
   3. Install base covers unless otherwise indicated.
D. Raise and set poles using web fabric slings (not chain or cable).

3.3 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION 265600

SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

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. Electronic safety and security equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   4. Common electronic safety and security installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.
B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.
B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
E. Cut sleeves to length for mounting flush with both surfaces of walls.
F. Extend sleeves installed in floors 6 inches above finished floor level.
G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
    1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".
J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.
B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION 280500

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Retain or delete this article in all Sections of Project Manual, Drawings and general provisions of the Contract, including General and Supplementary Conditions Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Fire alarm wire and cable.
   2. Identification products.

1.3 DEFINITIONS

A. Retain definition(s) remaining after this Section has been edited.
B. BICSI: Building Industry Consulting Service International.
C. EMI: Electromagnetic interference.
D. IDC: Insulation displacement connector.
E. 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.
F. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
G. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.
B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

C. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 FIRE ALARM WIRE AND CABLE

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. Comtran Corporation.
   2. Draka Cableteq USA.
   3. Genesis Cable Products; Honeywell International, Inc.
   4. Rockbestos-Suprenant Cable Corp.
   5. West Penn Wire; a brand of Belden Inc.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 14 AWG.
   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 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   1. Low-Voltage Circuits: No. 14 AWG, minimum.
   2. Line-Voltage Circuits: No. 12 AWG, minimum.
   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, and complying with requirements in UL 2196 for a 2-hour rating.

2.3 IDENTIFICATION PRODUCTS

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. Brady Corporation.
   2. HellermannTyton.
   3. Kroy LLC.
   4. PANDUIT CORP.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS
A. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
D. Pathway Installation in Equipment Rooms:
1. Extend conduits 84 inches above finished floor.
2. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.2 INSTALLATION OF HANGERS AND SUPPORTS
A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.3 WIRING METHOD
A. Coordinate this article with Drawings. Retain one of first three paragraphs below to specify wiring method.
B. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch.
C. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
D. Install cable, concealed in accessible ceilings, walls, and floors when possible.
E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4 FIRE ALARM WIRING INSTALLATION
A. Comply with NECA 1 and NFPA 72.
B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems." All raceways associated with fire alarm cabling shall be colored red.
1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."
B. Comply with TIA-569-B, "Firestopping" Annex A.
C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Perform tests and inspections.
C. Tests and Inspections:

1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. 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.
E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
F. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 280800 - COMMISSIONING OF DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 28.

1.2 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
B. Division 23 “Commissioning of HVAC”.
C. Division 26 “Commissioning of Electrical Systems”.

1.3 SUMMARY

A. This Section includes requirements for commissioning the digital, addressable fire alarm system.

1.4 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
B. CxA: Commissioning Authority.
C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Provide all labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing.
B. Perform commissioning tests at the direction of the CxA.
C. Attend construction phase coordination meetings.
D. Provide information requested by the CxA for final commissioning documentation.
E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for all digital, addressable fire alarm systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
B. Direct commissioning testing.
C. Provide test data, inspection reports, and certificates in Systems Manual.
D. The CxA will be appointed by and work directly for The School District.

1.7 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Process and schedule for completing construction checklists digital, addressable fire alarm system equipment, wiring and components to be verified and tested.
2. Test and inspection reports and certificates.
3. Corrective action documents.

1.8 SUBMITTALS

A. Certificates of readiness.
B. Certificates of completion of installation, inspection and testing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
B. The CxA shall prepare detailed testing plans, procedures, and checklists for all systems to be commissioned as part of this project.

END OF SECTION 280800

SECTION 283111 - DIGITAL, ADDRESSABLE 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. Section Includes:
   1. Manual fire-alarm boxes.
   2. System smoke detectors.
   3. Heat detectors.
   4. Notification appliances.
   5. Addressable interface device.
   6. Magnetic door holders.

1.3 DEFINITIONS

A. LED: Light-emitting diode.
B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.

1.5 SUBMITTALS

A. General Submittal Requirements:
   1. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified fire-alarm technician, Level III minimum.
      c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
   1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
   2. Include voltage drop calculations for notification appliance circuits.
   3. Include battery-size calculations.
   4. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
   5. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Provide copy of site-specific software to owner.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.

E. Software and Firmware Operational Documentation.
1. Software operating and upgrade manuals.
2. Program software backup: On magnetic media or compact disc, with data files.
3. Device address list.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm components from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.

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. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.7 PROJECT CONDITIONS

A. 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 according to requirements indicated:
1. Notify Owner and 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 Owner or Construction Manager's written permission.

1.8 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors and Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Keys and Tools: One extra set for access to locked and tamper proofed components.
5. Audible and Visual Notification Appliances: Three of each type installed.
6. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. All new devices shall be fully compatible with the existing fire alarm panel and system, and shall not cause any existing system warranties to be voided.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.

6. Close smoke dampers in air ducts of designated air-conditioning duct systems.
7. Release magnetically held doors.
8. Activate relays to shut down HVAC equipment and exhaust fans.
9. Recall elevators to primary or alternate recall floors.
10. Record events in the system memory.

C. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Failure or trouble with a carbon monoxide detector.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Elevator shunt-trip supervision.
3. Carbon monoxide detector activation.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators, and transmit signal to the supervising station. Record the event on system memory.

2.3 FIRE-ALARM CONTROL UNIT

A. The existing addressable fire alarm control panel, and all existing devices shall remain in service.
1. All new devices shall be fully compatible with existing system.
2. Secondary power: Upgrade existing batteries as necessary to provide sufficient capacity to operate the system in standby (non-alarm condition) mode for 24 hours followed by 15 minutes in alarm mode.
3. Programming: Contractor shall hire a qualified fire alarm vendor to re-program the existing fire alarm panel after all device additions and alterations are complete.

2.4 REMOTE BOOSTER POWER SUPPLY

A. Install Remote NAC Power Supplies (boosters) as required, to minimize NAC voltage drops. Remote NAC power supplies shall be treated as peripheral NAC devices and shall not be considered fire alarm control units.

B. The NAC power supplies shall be fully enclosed in a surface mounted steel enclosure with hinged door and cylinder lock, and finished in red enamel. Door keys shall be the identical to FACP enclosure keys. The enclosure shall have factory installed mounting brackets for additional UL listed fire alarm equipment within its cabinet. Enclosures shall be sized to allow ample space for interconnection of all components and field wiring, and up to 10AH batteries. All FACP addressable control modules required to initiate the required NAC power supply output functions shall be installed within the NAC power supply enclosure.

C. Remote booster power supplies shall provide four (4) synchronized Class B supervised and power limited, 24VDC filtered and regulated Notification Appliance Circuits (NACs). Each NAC output shall be configurable as a continuous 24Vdc auxiliary power output circuit. The booster power supply shall be capable of a total output of 10 amps @ 24VDC.

D. All visible and audible NACs within the facility shall be synchronized.

E. Upon failure of primary AC power, the remote power supply shall automatically switch over to secondary battery power without losing any system functions. It shall be possible to delay reporting of an AC power failure for up to 6 hours. All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately be annunciated locally as battery trouble. All power supply trouble conditions (DC power failure, ground faults, low batteries, and IDC/NAC circuit faults) shall identify the specific remote power supply affected at the main FACP. All power supply trouble conditions except loss of AC power shall report immediately.

F. The remote booster power supply shall be capable of recharging up to 24AH batteries to 70% capacity in 24 hours maximum. Batteries provided shall be sized to meet the same power supply performance requirements as the main FACP, as detailed elsewhere in this specification.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for

calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall 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.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall 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.).
   3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   4. Each sensor shall have multiple levels of detection sensitivity.
   5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
   6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.
   1. Mounting: Adapter plate for outlet box mounting.
   2. Testable by introducing test carbon monoxide into the sensing cell.
   3. Detector shall have an integral sounder base which shall emit a temporal 4 signal upon C.O. detection.
   4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
   5. Comply with UL 2075
   6. Locate, mount, and wire according to manufacturer's written instructions.
   7. Provide means for addressable connection to fire-alarm system. Upon activation, detector shall indicate a system supervisory signal and sound the integral alarm.

8. Test button simulates an alarm condition.

2.7 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections

B. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

C. Voice/Tone Notification Appliances:
   1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
   2. High-Range Units: Rated 2 to 15 W.
   3. Low-Range Units: Rated 1 to 2 W.
   4. Mounting: Flush.
   5. Matching Transformers: Tap range matched to acoustical environment of speaker location.

D. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
   1. Rated Light Output: as indicated on plans.
   2. Mounting: Wall or ceiling mounted as indicated on plans.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.
   6. Mounting Faceplate: Factory finished, white.

2.9 REMOTE ANNUNCIATOR

A. Existing remote annunciators shall remain in service.

B. Provide a framed graphic map in the building lobby adjacent to the existing annunciator. The graphic map shall indicate building zones which shall be coordinated with the programmed addresses of initiation devices to provide local fire responders with directional information.

2.10 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Existing digital alarm communicator transmitter shall remain in service.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

F. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated air-conditioning duct systems.
2. Supervisory connections at valve supervisory switches.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.
   a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
   b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. 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.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 283111

SECTION 310000 - EARTHWORK

PART 1 - GENERAL

1.1 EARTHWORK

A. Earthwork required for this work includes, but is not necessarily limited to filling and backfilling to attain indicated grades.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. Clearing and Grubbing - Section 311100
B. Erosion and Sediment Control – Section 312500
C. Dewatering – Section 312319
D. Rock Excavation – Section 312316

1.3 QUALITY ASSURANCE

A. Notify Engineer/Architect 48 hours in advance of any backfill of existing or new work including all underground utilities.

1.4 SUBMITTALS

A. Submit testing laboratory reports on imported fill within 10 days after receipt of same from the testing laboratory.

1.5 REFERENCE STANDARDS

A. The following test standards apply to the work under this section:
   1. ASTM D2216, “Laboratory Determination of Moisture Content of Soil.”
   2. ASTM D422, “Particle-Size Analysis of Soils.”
   3. ASTM D698, “Test method for Laboratory Compaction Characteristics of Soil Using Standard Effort.(Standard Proctor)
   4. ASTM D1557, “Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort.(Modified Proctor)
   5. ASTM D2922, “Density of Soil and Soil Aggregate in Place by nuclear Methods.”
   6. ASTM D2937, “Density of Soil in Place by the Drive-Cylinder Method.”
   7. ASTM D3107, “Test for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods.”

PART 2 - PRODUCTS

2.1 FILL MATERIALS, GENERAL

A. Fill and backfill material shall be subject to acceptance of the Engineer from site excavation or from offsite borrow.

2.2 ON-SITE BACKFILL MATERIALS

A. All on-site materials shall be soil or soil/rock mixture which is free from organic matter and other deleterious substances; it shall contain no rocks or lumps over six inches in greatest dimension, and not more than 15% of the rocks or lumps shall be larger than 2-1/2 inches in greatest dimension.

2.3 IMPORTED BACKFILL MATERIALS

A. All imported backfill materials shall meet with requirements of Article 2.2 above.

2.4 GRANULAR CUSHION

A. Granular cushion under all concrete slabs shall be crushed non-porous rock or uncrushed gravel complying with ASTM C33 Gradation Size No. 67, ¾" into No. 4.

2.5 OTHER MATERIALS:

A. All other materials, not specifically described but required for a complete and proper installation of work described in this Section, shall be as selected by the Contractor, subject to the acceptance of the Engineer/Architect.

PART 3 - EXECUTION

3.1 COORDINATION

A. Contractor shall coordinate all excavation work to be performed to avoid duplication of effort and to make maximum use of an open excavation by all trades.

B. At least 72 hours prior to excavating, Contractor shall contact the Owner's Representative at the beginning of each phase to arrange for utility locates in the construction area.

C. Time spent by Owner to identify utilities and status of utilities discovered during excavation and not shown on the Drawings shall not be the basis of a change order request from the Contractor.

3.2 PREPARATION

A. Protection structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards create by earthwork.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing".

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing" during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.3 ROCK EXCAVATION

A. Rock excavation includes excavation, removal and disposal of materials and obstructions encountered which, in the opinion of the Engineer/Architect, cannot be excavated except by drilling and blasting or by drilling and wedging. Typical of materials classified as rock are boulders 1.0 cubic yard or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

B. Intermittent drilling, blasting or ripping, performed to increase production and not necessary to permit excavation of material encountered, will not be classified as earth excavation.

C. Payment limits for rock excavation shall be limited to a maximum of one-foot (1 foot) horizontally outside the limits of the structure or pipe to be installed, and a maximum of six inches below the bottom of the pipe, conduit or structure to be installed in the excavation.
D. Rock excavation shall be paid for at the unit price per cubic yard bid in the proposal and only for those quantities verified by the Engineer/Architect in the field prior to backfill. It is understood that the price per cubic yard bid for rock excavation includes drilling,
E. blasting, excavation, splitting, removal, disposal of all rock and the furnishing and installation of suitable granular foundation material to properly support the pipe, conduit or structure to be installed in the excavation.

3.4 FILL AND COMPACTION

A. Backfill and new fill shall be placed in layers not exceeding 6 inches in depth, approximately parallel to the plain of the floor or concourse. Fill material shall be thoroughly compacted to 95% minimum density at optimum moisture content, as determined by the Laboratory Method of Test for Moisture-Density Relations of Soil. Using a 5.5 lb. rammer and 12 inch drop (ASTM D698). Filling shall be done as soon as possible, but not when ground is frozen or covered with ice or snow. This fill is to be allowed to set a sufficient time before concrete is placed. Where soil is backfilled, inside the building against exterior walls or areas not accessible to mechanical rollers, these areas shall be tamped by pneumatic hand tamping or equal; to give the same compaction as specified.

3.5 BACKFILLING PRIOR TO ACCEPTANCE

A. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by work of this Section, prior to all required inspections, tests and acceptance. Should any of the work be so enclosed or covered up before it has been accepted, uncover all such work at no additional cost to the Owner. After the work has been completely tested, inspected and accepted, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.

3.6 DEBRIS

A. No existing new debris will be used as fill material or be buried on site. Contractor will remove debris from site to a dumping facility approved by local, County, and State authorities.

3.7 OVER-EXCAVATION

A. Backfill all overexcavated areas with concrete or as specified for fill (3.7) at no additional cost to the owner.

3.8 GRADING

A. Except as otherwise directed by the Engineer, perform all rough and finish grading
B. required to attain the elevations indicated on the drawings. After grading is completed and the Engineer has finished his review, permit no further excavation, filling or grading except with the acceptance and the review of the

Engineer/Architect. Provide and place, at no additional cost to the Owner, any additional fill material from off-site, as may be necessary to produce sub-grades required or indicated. If excess fill exists, Contractor may remove and keep same, with the Engineer's acceptance and at no cost to the Owner.

3.9 TRENCHING

A. Perform all trenching required for the installation of the items where the trenching is not specifically described in other Sections of these Specifications. Make all trenches open vertical construction with sufficient width to provide free working space at both sides of the trench and around the installed items as required for caulking, joining, backfilling and compacting. Provide any required shoring and bracing.

3.10 FOUNDATION FOR PIPES

A. Grade the trench bottoms to provide a smooth, firm and stable foundation free of rock points throughout the length of the pipe. Place a minimum of six inches of the specified cohesionless material in the bottom of the trench.

3.11 BACKFILL FOR PIPES

A. After the pipe has been laid, true to line and grade, thoroughly bedded and covered, spread the on-site material in uniform lifts of not more than six inches in uncompacted thickness, and then compact as specified in this Section. Repeat the spreading and compacting procedure until adjacent grade level is attained.

3.12 CLEAN-UP AND REMOVALS

A. Contractor shall, at all times, keep the premises and/or site free from accumulations of waste materials, rubbish, superfluous earth, rock and dirt caused by the excavations, employees or construction of the building. At the completion of the work, Contractor shall remove all his rubbish and his tools from and about the building or premises.

3.13 SHORING AND BRACING

A. It shall be the sole responsibility of the Contractor to properly brace and shore all excavations. The Contractor shall be solely responsible to comply with all applicable codes, rules, laws, regulations, etc. of any and all agencies having jurisdiction over the proper shoring and bracing of excavations. The Owner, Engineer and Architect shall in no way be responsible for the Contractor's failure to comply or compliance with any regulation dealing with shoring and/or bracing of excavations, and will assume no responsibility for the maintenance or creation of a properly shored and braced excavation. There shall be no extra cost to the Owner for shoring and/or bracing.

3.14 QUALITY CONTROL: SUPERVISION, INSPECTION, AND RECORDS

A. The Contractor shall retain an Independent Testing Agency to perform fill sampling and testing. The work performed by the testing agency shall be supervised by a registered geotechnical engineer.

B. Test material gradation for all fill materials in accordance with ASTM 422.

Sample and test a minimum of one test per every 5,000 cubic yards placed.

C. Perform compaction testing of each lift of the embankment fill and final grading in accordance with ASTM D 1556 or ASTM D 6938. Perform at least one test for every 5,000 ft^2 of surface area. Report failing tests immediately to the Engineer.

D. A complete tabulation of all test results shall be certified by the independent Testing Agency and shall be delivered to the Engineer

END OF SECTION 310000

SECTION 311100 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All necessary clearing and grubbing of all trees, brush, stumps, fences, debris, miscellaneous materials and miscellaneous structures not covered under other Contract Items within the construction area.
B. Clear and grub such additional areas within the limits of the right-of-way and easement lines, or other such areas specifically noted or specified.
C. Stripping of topsoil from construction areas and all areas to be excavated or filled with material to be stockpiled as directed by the Owner and/or acceptable to the Engineer.
D. Removal and proper disposal of all materials noted herein and/or encountered during the work.

1.2 RELATED WORK

A. Earthwork – Section 310000
B. Erosion and Sediment Control – Section 312500
C. Rough Grading - 312213

1.3 EXISTING CONDITIONS

A. The locations of existing underground utilities are shown in an approximate way only. The Contractor shall determine the exact location of all existing utilities before commencing the work.
B. The Contractor shall contact the Underground Utilities Call Center and/or utilities individually as necessary for proper notification.
C. The Contractor agrees to be fully responsible for any and all damage, which might be occasioned by his failure to exactly locate and preserve any and all underground utilities.
D. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 – MATERIALS

2.1 All materials utilized for related work shall comply with the requirements of the individual specification sections.

PART 3 - CONSTRUCTION DETAILS

3.1 LIMIT OF WORK AREAS

A. In general, work areas shall include the areas shown on the plans or as specified.
B. Clearing beyond the areas of construction shall be done only where specified.

3.2 CLEARING AND GRUBBING

A. On or adjacent to Roadways - all trees felled or trimmed to be immediately removed so as not to present any hazard to traffic. Grubbed stumps to be moved

at least 30 feet from edge of pavement.

B. Embankments - grubbing will be required beneath all embankments unless otherwise specified by the Engineer.

C. Where trees or existing stumps are cleared and grubbing is not required, the tree trunk or existing stump shall be cut off not more than six (6) inches above the original ground surface, unless otherwise accepted. Exposed stumps not required to be removed but which are within 30' of the edge of the pavement shall be chipped out to a depth of not less than six (6) inches below the finished grade and the holes backfilled as accepted by the Engineer. This work shall be completed within one (1) week after start of work on the tree.

3.3 STRIPPING

A. Strip any topsoil from Contractor areas and all areas to be excavated or filled.

B. Prevent mixing of topsoil with subsoil.

C. Stockpile topsoil on-site in an area acceptable to the Owner and the Engineer.

D. Prevent brush, trash, large stones and other objectionable material from being placed with stockpiled topsoil.

E. Protect stockpiled topsoil during construction operations.

F. Remove remaining topsoil from the site after completion of all restoration work and when authorized by the Owner and/or Engineer.

3.4 DISPOSAL (GENERAL)

A. No burning will be permitted on or off the contract site. All material generated by any activity for the development, modification and construction of any transportation facility shall not be burned. This shall include but not be limited to land clearing material and demolition material. Such material shall hereinafter be referred to as disposable material.

B. All wood, including grubbed stumps, shall be removed from the contract site and shall be the responsibility of the Contractor.

3.5 DISPOSAL (METHODS)

A. Disposal (no burning). All wood and brush shall be disposed of within fifteen (15) days after cutting or felling, unless otherwise accepted in writing by the Engineer and the property owner. No burning of land clearing materials that results from clearing and grubbing operations will be permitted. The Contractor will have the following options or combination of options for disposal of this material.

B. The Contractor may bury the disposable material in conformance with all local and State laws, rules or regulations off the right-of-way in locations obtained by him at his own expense. If the disposal is not in conformance with local and State requirements, the Contractor shall bear the expense for any and all required corrections, remediation, etc.

C. The Contractor may reduce all woody materials to chips and dispose the chips in compliance with paragraph B of this subsection.

D. Chipping. Wood may be reduced to chips by the use of a chipping machine or stump grinder. The chips shall be 1/2 inch maximum thickness or of other acceptable thicknesses. Chips resulting therefrom may be disposed of by being stockpiled and used as mulch for planting, in the right-of-way as accepted by the property owner, or by disposal at a location obtained at the Contractor's expense

off the contract site.

E. Burying. No tree trunks, stumps, chips or other debris shall be buried at the work site. Disposal areas off site shall be acquired by the Contractor at his own expense.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Easement Areas or Right-of-Ways: Clearing and grubbing in easement areas or right-of-ways shall be included in the unit price bid under the payment items to be installed, constructed, etc., in the easement area or right-of-ways, and no separate payment will be made.

B. All Other Areas: Clearing and grubbing shall be included in the lump sum price bid under the "Clearing and Grubbing" item. If no such item for payment is provided within the proposal, the costs for the necessary clearing and grubbing shall be deemed included in the other prices bid in the proposal, and no separate payment for this work shall be made.

END OF SECTION 311100

SECTION 312213 - ROUGH GRADING (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Excavate and fill for roadways/walkways, parking areas, landscaped areas and areas of improvement or other work as shown on the Drawings to subgrade elevations (or final elevations, if applicable).
B. Compaction of subgrades for all roadways, walkways or other improvements.
C. Furnish and install additional subsoil, if required to complete the work.
D. Dewater excavations as required.
E. Protect and maintain the work site.
F. Proper disposal of all excess or waste materials, and any objectionable materials encountered.

1.2 RELATED WORK

A. Earthwork – Section 310000
B. Clearing and Grubbing - Section 311100
C. Erosion and Sediment Control – Section 312500
D. Rock Excavation - Section 312316
E. Trenching, Backfilling and Compacting - Section 312333
F. Finish Grading - Section 312219

1.3 EXISTING CONDITIONS

A. The locations of existing underground utilities are shown in an approximate way only. The Contractor shall determine the exact location of all existing utilities before commencing work.
B. The Contractor agrees to be fully responsible for any and all damage, which might be occasioned by his failure to exactly locate and preserve any and all underground utilities.

1.4 REFERENCE STANDARDS

A. The latest edition of the following standards, as referenced herein, shall be applicable.
B. "Standard Specifications, Construction and Materials, New York State Department of Transportation, Office of Engineering".
C. "Standard Specifications for Highway Materials and Methods of Sampling and Testing, American Association of State Highway and Transportation Officials (AASHTO)".
D. Requirements of Regulatory Agencies: Contractor shall comply with the requirements for soil erosion and sedimentation control and other requirements of governmental authorities having jurisdiction, including the State of New York.
    1. The following test standards apply to the work under this section:
        a. ASTM D2216, “Laboratory Determination of Moisture Content of Soil.”
        b. ASTM D422, “Particle-Size Analysis of Soils.”
        c. ASTM D698, “Test method for Laboratory Compaction Characteristics of Soil Using Standard Effort.(Standard Proctor)
        d. ASTM D1557, “Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort.(Modified Proctor)

e. ASTM D2922, “Density of Soil and Soil Aggregate in Place by nuclear Methods.”
f. ASTM D2937, “Density of Soil in Place by the Drive-Cylinder Method.”
g. ASTM D3107, “Test for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods.”

1.5 TESTING AGENCY

A. Contractor shall provide and pay for all costs in connection with an approved independent testing facility to determine conformance of soils and aggregate with the specifications.

1.6 SUBMITTALS REQUIRED

A. Samples: The Contractor shall furnish earth materials to the testing laboratory for their analysis and report, as directed by the Engineer.
B. Test Results: The testing laboratory shall submit written reports of all tests, investigations, findings and recommendations to the Contractor and the Engineer. The cost for the testing shall be borne by the Contractor.

1.7 PROJECT REQUIREMENTS

A. Notify the Engineer of any unexpected subsurface conditions.
B. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations. Comply with OSHA requirements.
C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for directions.
D. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner; at no cost to the Owner.
E. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, during occupied hours, except when permitted in writing by the Owner and then only after acceptable temporary utility services have been provided.
F. Provide a minimum of 48-hour notice to the Owner and receive written notice to proceed before interrupting any utility.
G. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are active.

1.8 USE OF EXPLOSIVES

A. Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted.

1.9 PROTECTION OF PERSONS AND PROPERTY

A. Barricade open excavations occurring as part of this work and post with adequate warning lights.
B. Operate warning lights as recommended by authorities having jurisdiction.
C. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

D. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.

1.10 EXCAVATION CLASSIFICATIONS

A. The following classifications of excavation will be made when rock excavation is encountered in work.

B. Earth excavation includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

C. Rock excavation in trenches and pits includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, (3/4 cu. yd. backhoe for smaller work), 24" wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90 HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10'-0" in width and pits in excess of 30'-0" in either length or width are classified as open excavation.

D. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty excavating equipment without drilling, blasting or ripping.

E. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170HP flywheel power and developing 40,000 lb. break-out force (measured in accordance with SAE J732C).

F. Typical of materials classified as rock are boulders 1.0 cu. yd. or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

G. Intermittent drilling, blasting or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

H. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by the Engineer.

I. Rock Payment Lines Are Limited To The Following:

1. Two feet outside of concrete work for which forms are required, except footings.
2. One foot outside perimeter of footings.
3. In pipe trenches, 6" below invert elevation of pipe 1' to either side of the pipe.
4. Neat outside dimensions of concrete work where no forms are required.
5. Under slabs on grade, verify subgrade depth requirement.
6. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific written acceptance of the Engineer or authorization by the Owner. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.

PART 2 - MATERIALS

2.1 SELECTED FILL

A. Selected fill is to be placed, as required, to replace deficient subsoil as directed by the Engineer. Selected fill is soil material native to the area, that is capable of being compacted to the specified densities and that is free from organic matter and other deleterious materials. Selected fill shall contain no stones larger than 2" at its greatest dimension, and shall contain no more than 10% clay or silt (passing the No. 200 sieve).
B. Local pockets of material that are substantially different in composition from the surrounding may be unsatisfactory for use as selected fill under certain climatic conditions. Do not use such materials without acceptance from the Engineer.
C. If sufficient selected fill material is not available from excavation under the Contract, additional fill suitable for use, shall be brought to the site from other sources.

PART 3 - EXECUTION

3.1 PREPARATION
A. Establish required lines, levels, contours and datum.
B. Maintain benchmarks and other elevation control points. Re-establish, if disturbed or destroyed, at no additional cost to the Owner.
C. Establish location and extent of utilities before commencement of grading operations.

3.2 ROUGH GRADING
A. Rough grade the project area to required subgrade levels and elevations as indicated on the drawings. The subgrades are as follows:
1. Sodded Areas: 6" below finished elevation.
2. Paved Areas: See details.
B. Prior to placing selected fill material over undisturbed soil, scarify to a depth of 6".
C. When grading operations have reached the required subgrade elevations, notify the Engineer for a review of the conditions.
D. Removal of materials beyond the indicated subgrade elevations without authorization by the Engineer will be classified as unauthorized excavation and shall be at no additional cost to the Owner.
E. Maintain slopes of excavation in safe condition until completion of grading operations.

3.3 DEWATERING
A. Prevent surface, subsurface or ground water from flowing into excavation and from flooding project area, as well as surrounding areas.
B. Do not allow water to accumulate in excavations. Remove water to prevent soil changes detrimental to the stability of subgrades.
C. Provide, operate and maintain a temporary dewatering system including pumps, well points, sumps, suction and discharge lines, and other dewatering components necessary to convey water away from excavations and control the groundwater level so that the necessary construction work can be properly performed.
D. Provide and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations by dewatering, to collection or runoff areas.
E. Dewatering operations shall be as acceptable to the Engineer.
F. The Contractor shall be fully responsible for, and shall correct at his own expense, any and all damages that may result from the operations of his dewatering system

or failure to make any provisions.

G. There shall be no discharge of silty, muddy or otherwise polluted water from any dewatering operation to a natural water course.

H. Provide, as necessary, sediment control measures to ensure that discharged waters are of the highest possible quality.

3.4 PLACEMENT AND COMPACTIO:

A. Place fill materials in layers not more than 8" loose depth for material compacted by heavy construction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.

B. Do not place fill material on surfaces that are muddy, frozen, or contain frost or ice.

3.5 PERCENTAGE OF MAXIMUM DENSITY REQUIREMENTS

A. Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils) determined in accordance with ASTM D1557; and not less than the following percentages of relative density, determined in accordance with ASTM D2409, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

3.6 PAVEMENTS:

A. Compact top 12" of subgrade and each layer of backfill or fill material at 90% maximum density for cohesive material or 95% relative density for cohesionless material.

3.7 LAWN OR UNPAVED AREAS:

A. Compact top 6" of subgrade and each layer of backfill or fill material at 85% maximum density for cohesive soils and 90% relative density for cohesionless soils.

3.8 MOISTURE CONTROL

A. 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, to prevent free water appearing on the surface during or subsequent to compaction operations.

B. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

C. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by dicing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.9 FIELD QUALITY CONTROL

A. The testing laboratory shall check the degree of compaction of all fill, including proof-rolling. Perform tests for each layer, of each kind of fill. Determine maximum density at optimum moisture for each material per ASTM D1557. Make field compaction tests per ASTM D1556. The in-place density specified is the relation of the field compaction test and the maximum density determination of the same soil. This testing shall be performed as requested by the Owner.

B. If in the opinion of the Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional cost to the Owner.
C. If so required by the Engineer, the Contractor shall at his own expense, perform turbidity sampling to insure that the construction operations have not negatively impacted a water course.
D. At all times, special measures shall be taken to prevent spillage of chemicals, fuels, oils, greases, bituminous materials, or any deleterious materials to the environment or any water course.

3.10 CLEANUP

A. Provide and maintain protections or newly filled areas against damage. Upon completion or when directed, correct all damaged and deficient work by building up low spots and remove temporary protections, fencing, shoring and bracing.
B. Remove all surplus excavated material not required for filling and backfilling and legally dispose of same away from premises.
C. Leave the premises and work in clean, satisfactory condition, ready to receive subsequent operations.

3.11 QUALITY CONTROL: SUPERVISION, INSPECTION, AND RECORDS

A. The Contractor shall retain an Independent Testing Agency to perform fill sampling and testing. The work performed by the testing agency shall be supervised by a registered geotechnical engineer.
B. Test material gradation for all fill materials in accordance with ASTM 422. Sample and test a minimum of one test per every 5,000 cubic yards placed.
C. Perform compaction testing of each lift of the embankment fill and final grading in accordance with ASTM D 1556 or ASTM D 6938. Perform at least one test for every 5,000 ft^2 of surface area. Report failing tests immediately to the Engineer.
D. A complete tabulation of all test results shall be certified by the independent Testing Agency and shall be delivered to the Engineer

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT:

A. Paved Areas
   1. Rough grading under and adjacent to paved areas shall be included in the unit price bid under the appropriate payment item for the paving work. If no such item exists, the work shall be deemed included in the other payment items of the Proposal.
B. Earthwork
   1. Rough grading related to a Site Grading Plan shall be included in the lump sum price bid under the "Earthwork" item. If no such item for payment is provided within the Proposal, and no other specific item for payment is provided, then the costs for the required rough grading shall be deemed included in the other prices bid in the Proposal, and no separate payment for this work shall be made.

END OF SECTION 312213

SECTION 312219 - FINISH GRADING (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Place, grade and compact topsoil, or other materials as may be called for, shown or required to complete the project work.

1.2 RELATED WORK

A. Earthwork – Section 310000
B. Rough Grading - Section 312213
C. Erosion and Sediment Control – Section 312500
D. Seeding - Section 329219
E. Topsoil Placement and Grading (Topsoil) - Section 329219.13

1.3 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to visit the entire project site and investigate all conditions that may affect his work.
B. The Contractor shall take all necessary as-built measurements and make all necessary investigations in the field, prior to layout of the proposed installation of the work.

1.4 COORDINATION

A. Coordinate the finish grading with the completion of the underground and other work of the project, before final restoration or paving is begun.

1.5 REFERENCE STANDARDS

A. The latest edition of the following standards, as referenced herein, shall be applicable.
B. "Standard Specifications, Construction and Materials, New York State Department of Transportation, Office of Engineering".
C. "Standard Specifications for Highway Materials and Methods of Sampling and Testing, American Association of State Highway and Transportation Officials (AASHTO)".
D. Requirements of Regulatory Agencies: Contractor shall comply with the requirements for soil erosion and sedimentation control and other requirements of governmental authorities having jurisdiction, including the State of New York.
E. The following test standards apply to the work under this section:
    1. ASTM D2216, “Laboratory Determination of Moisture Content of Soil.”
    2. ASTM D422, “Particle-Size Analysis of Soils.”
    3. ASTM D698, “Test method for Laboratory Compaction Characteristics of Soil Using Standard Effort.(Standard Proctor)
    4. ASTM D1557, “Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort.(Modified Proctor)
    5. ASTM D2922, “Density of Soil and Soil Aggregate in Place by nuclear

Methods."

6. ASTM D2937, "Density of Soil in Place by the Drive-Cylinder Method."
7. ASTM D3107, "Test for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods."

1.6 TESTING AGENCY

A. Contractor shall provide and pay for all costs in connection with an approved independent testing facility to determine conformance of soils and aggregate with the specifications.

1.7 SUBMITTALS REQUIRED

A. Samples: The Contractor shall furnish earth materials to the testing laboratory for their analysis and report, as directed by the Engineer.
B. Test Results: The testing laboratory shall submit written reports of all tests, investigations, findings and recommendations to the Contractor and also directly to the Engineer.

PART 2 - MATERIALS

2.1 TOPSOIL

A. Provide topsoil which is fertile, friable, natural loam, reasonably free of subsoil, clay lumps, brush, weeds, roots, stumps and other deleterious material.
B. Topsoil shall meet the requirements specified in Topsoil Specification 329119.13 unless otherwise indicated on the plans.

2.2 OTHER MATERIALS

A. Other materials as may be involved for finish grading work shall comply with the respective and applicable provisions as noted otherwise in these documents.

PART 3 - CONSTRUCTION DETAILS

3.1 STOCKPILING

A. Topsoil shall be stockpiled from on-site sources or provided from off-site sources and stockpiled if on-site quantities are deficient.
B. Stockpiles shall contain not less than 200 cu. yds. or the minimum required for the project.
C. Stockpiles shall have a height of at least 4' and shall be trimmed to uniform surfaces and slopes.
D. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded and put into an acceptable condition as required by the property Owner, and deemed acceptable by the Engineer.
E. Stockpiles shall be provided with suitable provisions for soil erosion prevention.

3.2 TOPSOIL PLANNING

A. Placing topsoil on compacted subgrades conforming with Section 312213, Rough Grading, only after subgrades have been accepted by the Engineer.

B. Scarify the subgrade parallel to the contours to permit sufficient bonding with the topsoil. Do not scarify to the extent that the subgrade stability and density is disrupted.
C. Place topsoil in areas where sodding is to be performed. Place a 4" minimum depth to the finished grade elevations as required.
D. Fine grade topsoil to eliminate uneven areas and to ensure proper drainage. Maintain finished grade elevations required.
E. Remove all stones, roots, grass, weeds or other foreign matter while placing.
F. Lightly compact the topsoil to ensure its stability.
G. Topsoil in an unworkable condition due to excessive moisture, frost, or other conditions shall not be placed until it is suitable for placement.

3.3 CLEAN-UP

A. Remove all surplus subsoil and topsoil from project site.
B. Leave the site in clean, satisfactory condition ready to receive subsequent operations.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Earthwork: Finish grading related to completion of the project work shall be deemed included in the lump sum and unit prices bid under the proposal items. No separate payment for this work shall be made.

END OF SECTION 312219 (NY)

SECTION 312316- ROCK REMOVAL (ROCK EXCAVATION) (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Removal of rock, within the payment limits, for installation of piping as shown on the plans or called for in the Specifications.
B. Removal of rock, within the payment limits, for installation of roadway surfaces, curbing and sidewalks as shown on the plans or called for in the Specifications.
C. Removal of all other rock, for structures or other improvements designated on the plans, called for in the Specifications or indicated in the field by the Engineer.
D. Proper disposal of all excavated rock at a location acceptable to the Owner and Engineer.
E. Provide selected borrow backfill to make up for any deficiencies due pursuant to the rock excavation. In roadway areas, or where otherwise called for, utilize Roadway Subbase Material.

1.2 RELATED WORK

A. Structural Excavation, Backfill, and Compaction (NY) – Section 312334

1.3 EXISTING CONDITIONS

A. Where information exists regarding the presence of rock within the work limits and same is made available by the Owner, the Engineer does not purport said information as being correct or having been verified and said information is made available only to assist the Contractor in determining those areas where previous data indicates the possibility of rock being encountered.
B. The Contractor shall, based on any subsurface information made available, make all interpretations using the information according to his own judgement.
C. The Owner and/or the Engineer shall assume no responsibility or liability pertaining to the Contractor's utilization or interpretation of any information made available.
D. The quantity indicated in the Contract Proposal is provided as an estimated quantity for the purpose of comparing bids and has been obtained using the information available at time of design.
E. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 All equipment utilized by the Contractor and/or subcontractors in his (their) performance of the work under this section shall comply with all provisions of local jurisdictions and/or agencies.

2.2 All equipment and/or procedures utilized in the possession, handling, storage and transportation of all explosives shall comply with the requirements of Industrial Code Rule 39 of the State of New York, Department of Labor, Board of Standards and Appeals, and the applicable conditions of Section 107-05 of the New York State Department of Transportation Standard Specifications.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL

A. The Contractor shall comply with Title 29, Code of Federal Regulations Part 1926, Safety and Health Regulations for Construction (OSHA) regarding the safety and protection of persons employed in construction and demolition work.
B. All blasting shall be done in compliance with all Federal, State and Local regulations.
C. The Contractor shall obtain all appropriate and required blasting permits from all applicable jurisdictions. The cost for all fees, bonds, etc., shall be paid for by the Contractor.
D. The Contractor shall provide any applicable supplemental Certificates of Insurance, or Certificates for the blasting subcontractor, to the Owner prior to any blasting work. All Certificates shall comply with the requirements elsewhere noted herein this document for Certificates of Insurance provided under this Contract.

3.2 PRECAUTIONS

A. In blasting, all necessary precautions shall be taken to protect persons and property.
B. The Contractor shall take all possible precautions to prevent accidents from blasting.
C. The Contractor shall be liable for all damages done to persons and/or property caused by blasts or explosives or from neglect in properly guarding the trenches. No compensation will be allowed said Contractor for loss so incurred.
D. Blasting shall be done only by workmen skilled in this kind of work. The Owner and/or the Engineer shall have the right to require references to suitably indicate the ability of the workmen to perform the work in a safe manner.
E. Rock shall be well covered and sufficient warning shall be given to all persons within the vicinity before blasting.

3.3 DEFINITION

A. Materials, which in the sole opinion of the Engineer cannot be excavated except by drilling and blasting or drilling and wedging, shall be considered rock.
B. Boulders exceeding 1.0 cubic yards will also be considered rock.
C. Materials such as hardpan or disintegrated rock and other materials which can be broken down with picks, sledge hammers or power activated mechanical equipment will not be considered rock even if the Contractor elects to remove such materials by drilling and blasting or drilling and wedging.
D. Intermittent drilling, blasting or ripping performed to increase production and not necessary to permit excavation of material encountered will not be classified as Rock Excavation.

3.4 METHODS

A. In general, blasts shall be covered with suitable blasting mats and/or heavy timbers.
B. All blasting work shall be completed within the excavation before other work is started there.
C. Caps or other exploders shall in no instance be kept near a place where dynamite or explosives are stored, and no more than 100 pounds of dynamite shall be stored in the vicinity of the work at any time except by special permission.
D. If so called "wagon drills" are used, the Contractor must, at a minimum, excavate test

pits on 200' centers and at all changes in alignment. These test pits must be excavated with a track mounted power excavator equivalent to a Caterpillar Model 215, rated at not less than 90HP flywheel power, and 30,000 lb. draw bar pull with a 24" wide bucket. The test pit shall be dug to refusal depth or subgrade line, whichever is less. The depth of disintegrated/fractured rock, which is able to be excavated as outlined above, shall be measured by the Engineer and averaged between successive test pits, to determine the amount and elevation of diggable rock present. If the top of rock is below the subgrade line, the next closest test pits diggable rock depth (elevation) shall be used for calculation purposes. The Engineer shall be the sole judge of when refusal is reached. The Engineer must be given a minimum of 72 hours prior written notice of test pits being dug.

E. After blasting and removal of the rock, the Contractor shall so clean the faces of the excavation that the upper surface of the rock can be easily determined for measurement. Boulders removed should be laid at the side of the trench and the Engineer notified and given ample time to measure the same.

F. When rock is encountered, it shall be stripped of all earth and left with a clean surface until the height of this surface is measured by the Engineer. The Contractor shall notify the Engineer upon same being prepared for measurement.

3.5 TIME FOR BLASTING

A. Blasting shall only be accepted between the hours of 8:00 a.m. and 5:00 p.m. on weekdays, except holidays, unless otherwise accepted by the Engineer.

B. No blasts shall be made on Sunday under any conditions.

C. Blasting times shall conform to the conditions of the issued permit and/or any local ordinances.

D. Should the Contractor wish to perform blasting at times other than noted in A (above), a request shall be made a minimum of 48 hours in advance, with acceptance of the Engineer conditional with approval of all other jurisdictions.

3.6 LIMITS OF ROCK EXCAVATION

A. Structures:

1. Two (2) feet outside of concrete work for which forms are required except footings.
2. One (1) foot outside perimeter of footings.
3. Underslabs on grade, verify subgrade depth requirements.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement will be made on the basis of cubic yards of non-diggable rock removed as measured by the Engineer. No separate payment will be made for test pits, exposing rock faces, etc., as required under this specification.

4.2 PAYMENT

A. Payment for rock excavation will be made based on the unit price bid for Rock Excavation as bid in the Contract Proposal. The unit price bid shall include the cost to furnish all labor, materials, equipment, the cost for the necessary selected borrow or

roadway subbase backfill, and incidental costs to complete the work.

B. In order to avoid unbalanced bids, the unit price for Rock Excavation is established at a minimum of thirty-five dollars ($35.00) and a maximum of one hundred dollars ($100.00) per cubic yard.

END OF SECTION 312316.26 (NY)

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill and construction. Control of surface water shall also be considered as part of the work under this specification.

1.2 SUMMARY

A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
   1. Implementation of the Erosion and Sedimentation Control Plan.
   2. Dewater excavations, including seepage and precipitation.
   3. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

1.3 PERFORMANCE REQUIRMENTS

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least (1 foot) below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated, and concrete placed, in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.
B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of (1 foot) below prevailing excavation surface.
C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.
D. Maintain stability of sides and bottom of excavation.
E. Construction operations are performed in the dry.
F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.
   5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

1.4 RELATED WORK

A. Rock Removal (Rock Excavation)(NY) - Section 312316

B. Structural Excavation, Backfill and Compaction – Section 312334

1.5 SUBMITTALS

A. Drawings and Design Data:
   1. Submit drawings and data showing the method to be employed in dewatering excavated areas 14 days before commencement of excavation.
   2. Material shall include: location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.
   3. Include a written report outlining control procedures to be adopted if dewatering problem arises.
   4. Capacities of pumps, prime movers, and standby equipment.
   5. Detailed description of dewatering procedure and maintenance method.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.
B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of (1 foot) below prevailing excavation surface at all times.

3.2 OPERATION

A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.
B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

3.3 WATER DISPOSAL

A. Dispose of water removed from the excavations in such a manner as:
   1. Will not endanger portions of work under construction or completed.
   2. Will cause no inconvenience to others working near site.
   3. Will comply with the stipulations of required permits for disposal of water.
   4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas.

All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.

B. Excavation Dewatering:
   1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.
   2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
   3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
   4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.

C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3.4 STANDBY EQUIPMENT

A. Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

3.5 CORRECTIVE ACTION

A. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure or damages to work in place resulting from such inadequacy or failure by Contractor, at no additional cost to the Owner.

3.6 DAMAGES

A. Immediately repair damages to adjacent facilities caused by dewatering operations.

3.7 REMOVAL

A. Insure compliance with all conditions of regulating permits and provide such information to the Resident Engineer. Obtain written approval from Resident Engineer before discontinuing operation of dewatering system.

END OF SECTION 312319

SECTION 31232.13.01- BACKFILL (CRUSHED STONE FOUNDATION) (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and place crushed stone foundation material at the depths and locations shown on the Plans and/or called for in the Specifications.

B. Furnish and place Crushed Stone Foundation material in areas or locations where, in the opinion of the Engineer, the subgrade will not properly support the pipe or structure.

C. As an alternate and where specific written acceptance of the Engineer is received, the Contractor shall be permitted to utilize sand as a foundation in lieu of crushed stone. At any time the material quality becomes questionable in the opinion of the Engineer, the acceptance can be withdrawn.

1.2 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

1.3 RELATED WORK

A. Trenching, Backfilling and Compaction - Section 312333 respectively

B. Structural Excavation, Backfill And Compaction – Section 312334

1.4 SUBMITTALS REQUIRED

A. Samples: The Contractor shall furnish earth materials to the testing laboratory for their analysis and report, as directed by the Engineer.

B. Test Results: The testing laboratory shall submit written reports of all tests, investigations, findings and recommendations to the Contractor and the Engineer. The cost for the testing shall be borne by the Contractor.

PART 2 - MATERIALS

2.1 GENERAL

A. The material shall conform to "Coarse Aggregates" Section 703-02, as specified in "Standard Specifications Construction and Materials, New York State Department of Transportation", latest edition.

B. Crushed stone material shall be approximately two-thirds (67%) of the sized stone indicated in the table below, with the remainder of mixed stone of other gradations as the Engineer may select due to the conditions.

C. Crushed stone provided shall be of the size noted below for the use indicated:

Use	Size
Piping Foundation	No. 2
Structures	No. 2
Curtain Drains	No. 3
All other uses (unless noted otherwise and subject to Engineer's acceptance)	No. 2

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL

A. All methods utilized for the placement of crushed stone foundation material shall comply with the details shown on the Plans for the type of work being performed.

B. Placement shall strictly comply with the specific requirements of the appropriate specification section(s) for the type of work being performed.

C. Foundation material shall be well compacted and leveled so that it will properly support the pipe or structure.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Selected Borrow Backfill placed to the minimum dimensions indicated on the Plans will be included under the individual prices bid for the respective Contract Items.

4.2 Selected Borrow Backfill placed to a height of 24 inches above piping will be included under the unit price bid for the respective Contract Item.

4.3 Measurement for all other "additional" Selected Borrow Backfill will be made on the basis of cubic yards of select borrow backfill in-place as measured by the Engineer. The Contractor is reminded that this material is to be placed only where required for the Engineer's acceptance of the work.

4.4 The Contractor is reminded that no payment will be made for Selected Borrow Backfill placed in connection with Rock Excavation, since the cost for such material is included under the Rock Excavation unit price bid.

4.5 The unit price bid per cubic yard shall include the cost of furnishing all labor, materials, tests and equipment necessary to complete the work. No additional payment will be made for disposal of unsuitable excavated material or for handling material to the point of placement.

4.6 Where no payment item is provided in the Contract Proposal, and selected borrow backfill is necessary or required to complete the work, no separate payment will be made and such material (in-place) shall be deemed included under the other payment items of the Proposal.

END OF SECTION 312323(NY)

SECTION 312323.13.02- BACKFILL (SELECTED BORROW BACKFILL)

PART 1 – GENERAL

1.1 WORK INCLUDED
- A. Furnish and place selected borrow backfill at the depths and locations shown on the Plans and/or called for in the Specification.
- B. Furnish and place selected borrow backfill to replace material considered by the Engineer to be unsuitable for backfill or to make up for deficiencies in quantity of suitable material where and when necessary and as required for acceptance by the Engineer.
- C. Furnish and place selected borrow backfill to replace rock excavated in accordance with Section 312316, although in this case payment for select borrow is deemed included under Rock Removal.
- D. Perform test pits and explorations to evaluate acceptability of borrowed material in the location the Contractor proposes to utilize for such material.

1.2 EXISTING CONDITIONS
- A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

1.3 RELATED WORK
- A. Trenching, Backfilling and Compaction - Section 312333

1.4 SUBMITTALS REQUIRED
- A. Samples: The Contractor shall furnish earth materials to the testing laboratory for their analysis and report, as directed by the Engineer.
- B. Test Results: The testing laboratory shall submit written reports of all tests, investigations, findings and recommendations to the Contractor and the Engineer. The cost for the testing shall be borne by the Contractor.

PART 2 - MATERIALS

2.1 GENERAL
- A. Selected borrow consists of unclassified material containing no rock or stones over 2" of its greatest dimension and containing no humus, topsoil or other objectionable materials.
- B. Shall contain no more than 10% clay or silt (passing the 200 sieve).
- C. Where selected granular backfill is specified on the drawings or elsewhere in the Technical Specifications, the granular fill shall conform to this section and, in addition, the granular fill shall conform with ASTM D2487, Class III soil types; GM, GC, SM, and SC.

2.2 ACCEPTANCE
- A. All materials utilized under this Section shall be as acceptable to the Engineer.

- B. A minimum of ten (10) days prior to taking any material from the source, the Contractor shall request the acceptance of the Engineer of the proposed borrow area.

C. Acceptability of the source and material will not be based only on the characteristics of the material but also on whether it will be satisfactory in that portion of trench in which it is to be used.
D. Any soil having a natural in-place moisture content in excess of 2 percent wetter than optimum moisture content, as determined by the ASTM Designation D1557, Method D, (year of latest revision) will not be considered as acceptable borrow material.
E. The Contractor shall supply any requested samples and pay for any testing laboratory fees to prove suitability of the selected borrow backfill.
F. Excavated material from the site can be used as select borrow backfill provided it is screened, tested and meets the general material requirements of this Technical Specification.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL
A. All methods utilized for the placement of selected borrow backfill shall comply with the details shown on the plans for the type of work being performed.
B. Placement shall strictly comply with the specific requirements of the appropriate Specification Section(s) for the type of work being performed.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT
A. Selected Borrow Backfill placed to the minimum dimensions indicated on the Plans will be included under the individual prices bid for the respective Contract Items.
B. Selected Borrow Backfill placed to a height of 24 inches above piping will be included under the unit price bid for the respective Contract Item.
C. Measurement for all other "additional" Selected Borrow Backfill will be made on the basis of cubic yards of select borrow backfill in-place as measured by the Engineer. The Contractor is reminded that this material is to be placed only where required for the Engineer's acceptance of the work.

4.2 PAYMENT
A. The Contractor is reminded that no payment will be made for Selected Borrow Backfill placed in connection with Rock Removal, since the cost for such material is included under the Rock Removal unit price bid.
B. The unit price bid per cubic yard shall include the cost of furnishing all labor, materials, tests and equipment necessary to complete the work. No additional payment will be made for disposal of unsuitable excavated material or for handling material to the point of placement.
C. Where no payment item is provided in the Contract Proposal, and selected borrow backfill is necessary or required to complete the work, no separate payment will be made and such material (in-place) shall be deemed included under the other payment items of the Proposal.

END OF SECTION 312323.13

SECTION 312323.13.03 - BACKFILL (SUBBASE MATERIAL) (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and place subbase material at the depths and locations shown on the Plans and/or called for in the Specifications.

B. Furnish and place subbase material to make up for deficiencies in the quantity of suitable subbase material or quality of subgrade where and when necessary and as required for acceptance by the Engineer.

C. Furnish and place subbase material to replace rock excavated in accordance with Section 312616, although in this case payment for subbase is deemed included under Rock Excavation.

D. Subbase material, unless otherwise noted, shall be NYSDOT Subbase Course, Item 304.15, also meeting the requirements noted herein.

1.2 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 MATERIALS REQUIREMENTS

A. Materials for subbase course shall consist of sand and gravel, approved blast furnace slag or stone. All materials furnished shall be well graded from coarse to fine and free from organic or other deleterious materials.

B. It shall be the Contractor's responsibility to provide material which meets this specification and is within his capabilities to fine grade to the required tolerances. Should the subbase course become unstable at any time prior to the placement of the overlying course due to the gradation of the material furnished, the Contractor shall, at his own expense, correct the unstable condition to the satisfaction of the Engineer.

C. Materials furnished for Types 1 and 4 shall consist of approved blast furnace slag, stone, sand and gravel or blends of these materials. Material furnished for Type 2 shall consist solely of acceptable blast furnace slab or of stone which is the product of crushing ledge rock.

D. Gradation

Type	Sieve Size Designation	Percent Passing by Weight
1	3 inch (75mm)	100
	2 inch (50mm)	90-100
	1/4 inch (6.3mm)	30-65
	No. 40	5-40
	No. 200	0-10

2	2 inch (50mm)	100
	1/4 inch (6.3mm)	5-60
	No. 40	5-40
	No. 200	0-10
4	2 inch (50mm)	100
	1/4 inch (6.3mm)	30-65
	No. 40	5-40
	No. 200	0-10

E. Soundness
   1. Material for Types 1, 2, and 4 will be accepted on the basis of a Magnesium Sulfate Soundness Loss after 4 cycles of 20 percent or less.

F. Plasticity Index:
   1. The Plasticity Index of the material passing the No. 40 mesh sieve shall not exceed 5.0.

G. Elongated Particles
   1. Not more than 30 percent, by weight, of the particles retained on a 1/2 inch sieve shall consist of flat or elongated particles. A flat or elongated particle is defined herein as one which has its greatest dimension more than 3 times its least dimension. Acceptance for this requirement will normally be based on a visual inspection by the Engineer. When the Engineer elects to test for this requirement, material with a percentage greater than 30 will be rejected.
   2. All material shall meet the specified gradation prior to placement on the grade. All processing shall be completed at the source.

PART 4 - CONSTRUCTION DETAILS

4.1 GENERAL

A. All methods utilized for the placement of subbase course shall comply with the details shown on the plans for the work being performed.

B. Placement shall strictly comply with the specific requirements of the appropriate specification section(s) for the work being performed.

C. Subbase material shall be compacted and leveled so that it will properly support the pavement structure or other improvement as indicated on the Plans.

4.2 MEASUREMENT AND PAYMENT

A. Subbase Material placed to the minimum dimensions indicated on the Plans will be included under the individual prices bid for the respective Contract Items.

B. Subbase material placed to the minimum requirements and dimensions shown on the drawings for pavement restoration or new pavement construction shall be included in the unit price bid for the applicable pavement Item.

C. Measurement for all other "Additional" Subbase Material will be made on the basis of cubic yards of material in-place as measured by the Engineer. The Contractor is reminded that this "additional" material is to be placed only where required for the Engineer's acceptance of the work.

D. The unit price bid per cubic yard shall include the cost of furnishing all labor, materials, tests and equipment necessary to complete the work. No additional

payment will be made for the excavation and disposal of unsuitable excavated material or for handling the material to the point of placement.

END OF SECTION 312323.13.03

SECTION 312333 - TRENCHING, BACKFILLING AND COMPACTION WORK (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Excavate for all pipe lines, conduits, culvert pipes, utility, walls, structures and other improvements shown on the Plans or called for in the Specifications.
B. Excavate within the limits of the Contract as necessary for the completion of the work.
C. Place and thoroughly compact granular beds and fills over the pipes, services or other improvements, to rough grade elevations after satisfactorily testing.
D. Dewater excavations so that no piping, conduit, concrete work, etc. is installed in water and so that a firm stable, firm bedding is provided.

1.2 RELATED WORK

A. Earthwork – Section 310000
B. Rough Grading - Section 312213
C. Dewatering – Section 312319
D. Erosion and Sediment Control – Section 312500
E. Seeding - Section 329219
F. Topsoil Placement and Grading (Topsoil) - Section 329219.13

1.3 EXISTING CONDITIONS

A. Locations of existing underground utilities are shown in an approximate way only.
B. The Contractor shall determine the exact location of all existing utilities before commencing work. The Contractor shall also consult with applicable Utility Companies for locations.
C. The Contractor shall notify the Underground Utilities Call Center a minimum of three (3) working days prior to the work.
D. The Contractor agrees to be fully responsible for any and all damage, which might be occasioned by his failure to exactly locate and preserve any and all underground Utilities.
E. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

1.4 REFERENCE STANDARDS

A. The following test standards apply to the work under this section:
    1. ASTM D2216, “Laboratory Determination of Moisture Content of Soil.”
    2. ASTM D422, “Particle-Size Analysis of Soils.”
    3. ASTM D698, “Test method for Laboratory Compaction Characteristics of Soil Using Standard Effort.(Standard Proctor)
    4. ASTM D1557, “Test method for Laboratory Compaction Characteristics of Soil Using Modified Effort.(Modified Proctor)
    5. ASTM D2922, “Density of Soil and Soil Aggregate in Place by nuclear Methods.”
    6. ASTM D2937, “Density of Soil in Place by the Drive-Cylinder Method.”
    7. ASTM D3107, “Test for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods.”

1.5 SUBMITTALS REQUIRED

A. Samples: The Contractor shall furnish earth materials such as select backfill if required to the testing laboratory for their analysis and report, as acceptable to the Engineer.

B. Test Results: The testing laboratory shall submit written reports of all tests, investigations, findings and recommendations to the Contractor and the Engineer.

C. Original signed copies of all reports shall be sent directly to the Engineer.

D. Design drawings showing the spacing of all whalers, bracing or other structural components required for all sheeting (wood or steel) shall be provided bearing the original seal and signature of a licensed P.E. in the State of New York. Said drawings shall be placed on record for the project; the Owner nor their agents will review or approve same as a function of their responsibilities. The Contractor shall be fully responsible for the safety of the project operations, as noted under Sections 11 and 12 of the General Conditions.

1.6 PROJECT REQUIREMENTS

A. Protect excavations by shoring, bracing, sheet piling, underpinning or by other methods, as required to ensure the stability of the excavation.

B. Underpin or otherwise support structure and other facilities and lines adjacent to the excavation which may be damaged by the excavation. This includes service lines.

C. Immediately notify the Engineer of any unexpected subsurface conditions.

D. Existing Utilities: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations. Comply with OSHA requirements:

E. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for directions.

F. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation.

G. Repair damaged utilities to satisfaction of utility owner; at no cost to the Owner.

H. Do not interrupt existing utilities serving facilities occupied and used by the Owner or others, during occupied hours, except when permitted in writing by the Owner and then only after acceptable temporary utility services have been provided.

I. Provide a minimum of 48-hour notice to the Owner and receive written notice to proceed before interrupting any utility.

J. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for temporary shutoff of services if lines are active.

1.7 USE OF EXPLOSIVES

A. Do not bring explosives onto site or use in work without prior written permission from authorities having jurisdiction. Contractor is solely responsible for handling, storage, and use of explosive materials when their use is permitted.

B. Obtain all necessary permits, bonds, Certificates of Insurance and other such authorizations and pay all necessary fees and costs as required by all applicable jurisdictions.

1.8 PROTECTION

A. Protection of Persons and Property: Barricade open excavations occurring as part of

this work and post with warning lights.

B. Operate warning lights as recommended by authorities having jurisdiction.

C. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

D. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.

1.9 EXCAVATION CLASSIFICATIONS

A. The following classifications of excavation are applicable to this project:

1. Unclassified Excavation - Includes excavation of earth, pavements and other obstructions visible or not visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with any other earth or other materials encountered that are not classified as rock or unauthorized excavation.

2. Rock Excavation - Includes removal and disposal of materials and obstructions encountered, which in the opinion of the Engineer, cannot be excavated except by drilling and blasting or drilling and wedging (as further defined under Section 312316.26).

3. Unauthorized Excavation - Consists of the removal of materials beyond indicated subgrade elevations or dimensions without specific acceptance of the Engineer. Unauthorized excavation, as well as the remedial work required to obtain acceptance from the Engineer, shall be at the Contractor's expense.

PART 2 - MATERIALS

2.1 BEDDING MATERIAL

A. Crushed stone shall conform to the requirements of the Standard Specification's Construction and Materials, New York State Department of Transportation and the requirements of Section 321123, "Crushed Stone Foundation".

B. Sand shall conform to the requirements of NYSDOT Section 703-06 and meet the requirements following gradation requirements:

Sieve Size	% Passing
1/4"	100
No. 50	0-35
No. 100	0-10

2.2 BACKFILL MATERIALS

A. Selected Borrow Backfill and Selected Granular Backfill: Selected fill is soil material native to the area, that is capable of being compacted to specified densities and that is free from organic matter, humus, topsoil, and other deleterious materials. Selected fill shall conform to Section 312323.13.2.

B. If sufficient selected fill material is not available from excavation under the contract, additional fill suitable for use, shall be brought to the site from other sources. Additional or separate payment for such materials shall only be made where so

provided in the Contract Proposal.

PART 3 - CONSTRUCTION DETAILS

3.1 PREPARATION

A. All subgrades shall be formed of suitable material free from sod, roots, stumps, trees, brush and frozen soil or any other objectionable material.
B. All techniques and equipment used to place the material shall provide an embankment uniformly compacted to the required grades.
C. Any portion of subgrade which, in the opinion of the Engineer, has been damaged by the Contractor's equipment in the progress of his work shall be corrected to the satisfaction of the Engineer by the Contractor.
D. The Contractor shall:
    1. Establish extent of excavation by area and elevation as indicated on the drawings.
    2. Set required lines and elevations.
    3. Maintain benchmarks and other elevation control points. Re-establish, if disturbed or destroyed, at no additional cost to the Owner.
    4. Accurately determine all existing utility line elevations and locations prior to any excavation or work being undertaken.

3.2 TRENCHING

A. Excavation
    1. Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 12" clearance on both sides of pipe or conduit.
    2. Excavate the trenches to depth indicated or required. Carry the depth of trenches for piping to establish indicated flow lines and invert elevations.
    3. Trim and shape trench bottoms and leave free of irregularities, lumps, and projections.
    4. Stockpile excavated subsoil for reuse where required. Remove excess or unsuitable excavated subsoil from site.
    5. Do not backfill trenches until tests and inspections have been made.
    6. The Contractor shall conduct all rock excavation operations, including blasting, in strict accordance with all State and Local laws and ordinances and he shall exercise maximum precautions including the use of mats in order to avoid damage to property and utilities.
    7. The bottom of the excavation shall not be disturbed and the final removal of material to grade shall not be made until just before the pipe, structure or improvement is to be placed.
    8. Removing and loosening material on the back slopes of cut sections shall be avoided, and any such material removed or loosened shall be replaced and thoroughly compacted to the required cross section at the Contractor's expense.
B. Stability of Excavation
    1. The Contractor shall be responsible for providing a safe and prudent excavation operation in a manner so that the workers, public and authorities will be protected from unreasonable hazard.
    2. Slope sides of excavations to comply with local codes and ordinances having

jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Comply with OSHA requirements.

3. Maintain sides and slopes of excavation in safe condition until completion of backfilling.
4. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights stringers, and cross-braces, in good serviceable condition.
5. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.
6. For the safety of personnel, sheeting shall be used as required in any trench or excavation more than five (5) feet above the personnel's footing.

3.3 DRAINAGE AND DEWATERING

A. The Contractor shall maintain all excavations, slopes and all surfaces such that satisfactory drainage is insured at all times.
B. Temporary facilities shall be provided when the Contractor finds it is necessary to interrupt the existing sewers, drainage pipes or surface drainage facilities and these temporary facilities shall be considered incidental to the construction of the project.
C. The Contractor shall excavate and dispose of seepage pockets of soft, wet, unstable materials, as acceptable to the Engineer. The excavated areas shall be immediately backfilled and covered with accepted granular material as necessary for acceptance by the Engineer.
D. In addition the Contractor shall:
    1. Prevent surface, subsurface or ground water from flowing into excavation and from flooding project area, as well as surrounding areas.
    2. Not allow water to accumulate in excavations.
    3. Remove water to prevent soil changes detrimental to the stability of subgrades.
    4. Provide, operate and maintain a temporary dewatering system including pumps, well points, sumps suction and discharge lines, and other dewatering components necessary to convey water away from excavations and control the groundwater level so that the necessary construction work can be properly performed.
    5. Provide and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations by dewatering, to collecting or run-off areas.
    6. Insure that no damages result from improper drainage and dewatering implementation; the Contractor shall be fully responsible for, and shall correct at his own expense, any and all such damages which may result from his operations or failure to make any provisions.
E. Dewatering operations shall be as acceptable to the Engineer.
F. The Contractor shall be fully responsible for the diversion of all drainage flows. The Contractor shall maintain the efficiency of all existing drainage systems both underground and surface.
G. There shall be no discharge of silty, muddy or otherwise polluted water from any dewatering operation to any natural water course. Temporary facilities to prevent same shall be understood as a requirement of their project, provided at no cost to the Owner.
H. Provide, as necessary and acceptable to the Engineer, sediment control measures to ensure that discharged waters are of the highest possible quality.

3.4 BEDDING

A. Place the type and thickness of bedding as indicated on the drawings.
B. Place systematically to create a uniform stable surface true to grade to ensure proper bedding of the pipe, structure or improvement.

3.5 PLACEMENT OF PIPE (GENERAL)

A. All pipe shall be placed in accordance with the specific requirements of the applicable technical specification section.
B. All pipe shall be inspected prior to being placed in the trench. Defective materials shall be immediately removed from the project site.
C. All pipe shall be laid at the location and grade shown on the plans and as necessary for completed work acceptable to the Engineer.
D. A suitable base in conformance will any details shown, shall be provided to support the pipe throughout its entire length.
E. All work shall be subject to testing and acceptance of Engineer and all applicable authorities.

3.6 PLACEMENT OF PIPE

A. Unless specifically noted otherwise in other Specification sections, placement shall at minimum comply with these requirements.
B. Special care shall be exercised in placing and compacting of the material, immediately adjacent to the pipe in order to avoid damage, either to the pipe or its alignment.
C. Any pipe that is damaged or moved out of alignment, regardless of cause, shall be replaced at no cost to the Owner.
D. All culverts shall be completed, backfilled and compacted before the road is rough graded.
E. Only if no other requirements are delineated in other Specification Sections and no details are provided; at minimum, in backfilling, loose, selected fine earth backfill free from stones shall be placed manually to a point two (2) feet above the top of pipes. From the bottom of the trench to the spring line of the pipe, the filling shall be thoroughly compacted by the use of tampers or similar implements and shall be brought up evenly on both sides of the pipe. The balance of the trench may be filled with "run-of-trench" materials, well compacted, except that no stone or rock shall be greater than 4" at its greatest dimension.

3.7 BACKFILLING

A. Backfill excavation as promptly as work permits, but not until completion of the following:
    1. Observation, testing, acceptance, and recording locations of underground improvements by the Contractor for the as-built drawings required under Section 18 of the Special Provisions, or for measurement taken by the Owner or the Engineer for the records or purposes.
    2. Removal of concrete formwork.
    3. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
    4. Removal of trash and debris.

B. The type of materials to be used in bedding, filling and backfilling at the structures, culverts, pipes or other improvements and the procedure of placement shall be in strict accordance with the details shown as noted on the plans and/or in the specifications.
C. Ensure trenches are free of snow, ice and water and that ground surface are not frozen.
D. Fill and backfill within, around and including that against the exterior of foundation walls shall be placed in uniform horizontal layers not exceeding six (6) inches in thickness before compaction. The material shall be spread on the existing subgrade after all sod, topsoil and unsuitable material has been stripped and removed. All portions of each layer shall be compacted with a minimum of three (3) passes of an acceptable vibrating roller. In areas inaccessible to the roller, a vibrating plate compactor or an impact rammer shall be used.
E. Otherwise, place backfill and fill materials in layers not more than 9" in loose depth for material compacted by heavy compaction equipment, and not more than 6" in loose depth for material compacted by hand-operated tampers.
F. In backfilling, special care shall be taken to thoroughly compact the material. No refilling shall be made with frozen earth, and no refilled trench shall contain more than one-third (1/3) stone, unless otherwise acceptable to the Engineer. Material in the opinion of the Engineer to be unsuitable for backfilling shall not be used.
G. Place backfill to the subgrade elevations of further indicated work.
H. Use care in backfilling to avoid damage or displacement of pipe systems.
I. Maintain optimum moisture content of fill materials in order to attain required compaction density.
J. Compact in conformance with specific requirements noted hereinbelow.
K. Remove surplus fill materials from site to a proper disposal area.

3.8 COMPACTION

A. A thoroughly and satisfactorily compacted earth subgrade is defined as having a minimum dry density of 90 percent of the maximum density. However, where the material consists of sand and gravel mixtures containing less than 20 percent, by weight, of particles passing the No. 200 mesh sieve, as determined by washing through the sieve in accordance with ASTM Designation D1140 (latest revision), a minimum dry density of 95 percent of the Maximum Density will be required. The in-place density shall be determined by ASTM Designation D 6938 (latest revision).
B. All fill material shall be compacted at a moisture content suitable for obtaining the required density. In no case, shall the moisture content be less than three (3) percent drier than the Optimum Moisture Content determined by the ASTM Designation D1557(latest revision), Method D.
C. When the moisture content of the material in the layer is less than the required amount, water shall be added by pressure distributors or other equipment; water may be added also in excavation or borrow pits. Water shall be uniformly and thoroughly incorporated into the soil by discing, harrowing, blading or by other acceptable means. This manipulation may be omitted for coarse and gravel soils. When the moisture content of material is in excess of the required Optimum amount, dry material shall be thoroughly incorporated into the wet material, or wet material shall be dried to the required Optimum by evaporation.
D. Any method or combination of methods used for the purpose of drying shall be subject to acceptance by the Engineer.
E. Maximum Density is defined as the maximum dry weight density in pounds per cubic

foot as determined by ASTM D-1557 (latest revision), Method D.

F. Embankments - Where the subgrade material contains less than one third (1/3), by volume, of stones or rocks larger than six (6) inches in greatest dimension, it shall be placed in successive uniform layers not exceeding eight (8) inches in thickness, loose measure, over the entire area of the embankment. Each layer shall be thoroughly rolled over its entire area with equipment intended for use to provide a uniformly compacted embankment, as acceptable to the Engineer. Equipment must be on the site prior to the start of construction of any embankment. All equipment must be in good working order. Pneumatic tired rollers shall have an operating weight of not less than 1000 pounds per tire. Smooth steel wheel rollers shall have a minimum weight of ten (10) tons and shall exert pressure of not less than 300 pounds per lineal inch of compression wheel or roll width.

G. All testing required to demonstrate compaction in compliance with these specifications shall be provided at the expense of the Contractor.

3.9 FIELD QUALITY CONTROL

A. The testing laboratory shall check the degree of compaction of all fill, including proof-rolling. Perform tests for each layer, of each kind of fill. Determine maximum density at optimum moisture for each material per ASTM D1557. Make field compaction tests per ASTM D 6938. The in-place density specified is the relation of the field compaction test and the maximum density determination of the same soil. This testing shall be performed as requested by the Engineer.

B. If, in the opinion of the Engineer, based on testing service reports and inspection, subgrade or fills which have been placed are below specified density, provide additional compaction and testing at no additional cost to the Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Payment for all Trenching, Backfilling and Compaction shall be included in the individual prices bid in the Proposal.

B. It is possible that groundwater will be encountered on the project site. Any costs incurred for the dewatering of excavations and for the installations, operation and maintenance of any and all dewatering facilities shall be deemed included in the prices bid in the proposal.

C. For all timber used for sheeting, bracing, etc., which is not shown upon the drawings to be left in place and which shall not be left as necessary for acceptance of the Engineer or as noted in writing to be left in place during the progress of the work, but which shall be actually left in the ground for convenience or to serve the interests of the Contractor, the Contractor shall receive no payment, it being understood and agreed that his compensation therefore is included in the prices bid in the Proposal.

D. There will be no separate payment made for any work, materials or testing required for compliance with this Section.

END OF SECTION 312333 (NY)

SECTION 312500 - EROSION AND SEDIMENT CONTROL (NY)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. This Section includes erosion and sediment control measures. The Owner's Representative has the authority to limit the surface area of earth exposed by earthwork operations and to direct the Contractor to provide immediate temporary or permanent erosion or pollution control measures to minimize damage to property, dirt tracked onto roadways from vehicles, and contamination of watercourses and water impoundments.

B. The Contractor has the ultimate responsibility for providing adequate erosion control and water quality throughout the duration of the project. The Contractor shall provide all measures that may be needed to control erosion and water pollution.

C. In the event of a conflict between the Contract Plans, the reference standards herein, and the requirements laws, rules, or regulations of any other Federal, State, or local agency having jurisdiction, the more restrictive requirement shall apply.

1.3 RELATED SECTIONS:

A. The following sections contain related information:

1. Earthwork – Section 310000
2. Clearing and Grubbing – Section 311100
3. Rough Grading - Section 312213
4. Final Grading – Section 312219
5. Trenching, Backfilling and Compaction – Section 312333
6. Topsoil – Section 329119.13
7. Seeding – Section 329219

1.4 REFERENCE STANDARDS:

A. New York State Standards and Specifications for Erosion and Sediment Control Manual, latest edition.

B. New York State (NYS) Stormwater Management Design Manual, latest edition.

1.5 SUBMITTALS:

A. Erosion and Sediment Control Plan: Shall include methods of erosion control for the project in general, methods along haul roads and/or borrow pits, plans for disposal of waste material, and temporary stream crossing plans, as applicable.

B. Product Data: Provide catalog sheets or shop drawings for each type of product to be utilized as called for on the contract plans. Acceptable products for erosion control include, but are not limited to the following:

1. Compost Filter Sock.
2. Hay Bale.
3. Mulches.

4. Stream Protection.
5. Seed, Fertilizer.

1.6 QUALITY CONTROL:

A. Contractor shall retain the services of a certified E&SC inspector for construction storm water management inspections. The inspector shall have taken a 4-hour E&SC training course endorsed by the New York State Department of Environmental Conservation.

PART 2 - PRODUCTS

2.1 GENERAL:

A. Products shall conform to the latest edition of the New York State Erosion and Sediment Control Manual. Only products allowed under this manual shall be approvable by the Engineer.

2.2 SOIL MATERIALS:

A. Mulches: Materials that meet minimum requirements published in Table 3.7 of the New York State Erosion and Sediment Control Manual. Anchoring material shall be Table 3.8 of the New York State Erosion and Sediment Control Manual.
B. Grasses: Seed mixture as specified in Division 31 Section “Seeding” or other species suitable for temporary cover that will not compete with the grasses sown later for permanent cover.
C. Jute Matting: Enkamat 7010 or approved equal.

2.3 COMPOST FILTER SOCK:

A. The compost filter sock shall be in accordance with the NYS Standards and Specifications for Erosion and Sediment Control (latest edition).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

A. Where applicable, installation of all erosion and sediment control devices shall be performed pursuant to the more restrictive of:
   1. Manufacturer’s written instructions.
   2. Specifications as published in the New York State (NYS) Standards for Erosion and Sediment Control.
   3. Specifications as published in Appendix C of the New York State (NYS) Stormwater Management Design Manual.
B. Installation of all erosion control devices shall occur prior to site disturbance to the maximum extent possible.
C. All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to ensure continued performance of their intended function.
D. Owner will monitor Contractor’s erosion control and work methods.

   1. If the overall function and intent of erosion control is not being met, Owner will require Contractor to provide additional measures as required to obtain the desired results.
   2. The erosion control features installed by Contractor shall be adequately maintained

by Contractor until the project is accepted.

E. Working In or Crossing Watercourses and Wetlands:
   1. Construction vehicles shall be kept out of watercourses to the extent possible.
      a. Where in-channel work is necessary, precautions shall be taken to stabilize the work area during construction to minimize erosion.
   2. The channel (including bed and banks) shall always be re-stabilized immediately after in-channel work is completed.
   3. Where a live (wet) watercourse must be crossed by construction vehicles during construction, a Temporary Stream Crossing in accordance with the latest NYS Erosion and Sediment Control Manual shall be provided for this purpose.

3.2 PROTECTION OF ADJACENT PROPERTIES:
A. Properties adjacent to the project site(s) shall be protected from loss of soil due to erosion as well as sediment deposition.
B. In addition to the erosion control measures required on the Contract Plans, perimeter controls may be required if damage to adjacent properties is likely, and may include, but is not limited to:
   1. Sediment barriers such as straw bales, erosion logs, and compost filter sock.
   2. Diversion swales.
   3. Sediment basins.
   4. Combination of above measures.

3.3 STABILIZED CONSTRUCTION ENTRANCE:
A. Stabilized construction entrances shall be provided at all construction site traffic entrance/exit points, outside of paved entrances or as specified in the *Standard Specifications For Stabilized Construction Entrance* included in the New York Guidelines for Urban Erosion and Sediment Control.
B. The stabilized construction entrances shall be provided prior to any activity on the site; maintained throughout construction and removed, and area restored, following construction.
C. The intent of the entrance is to prevent sediment from depositing upon Town, County, and State roadways. The Contractor's plans to enter and exit the construction site may require additional installations to achieve this goal. These will be provided as required to provide complete site access coverage, at no cost to the Owner.

3.4 MULCHES:
A. Ensure other erosion control measures are in place prior to mulching.
B. Slope and grade site to fit needs of selected mulch products.
C. Remove all undesirable stones and debris.
D. Install and anchor mulch according to Tables 3.7 and 3.8 of the New York State Erosion and Sediment Control Manual.

3.5 COMPOST FILTER SOCK AND HAYBALES:
A. Compost Filter Sock and haybales, as specified in the Standard Specifications included in the New York Guidelines for Urban Erosion and Sediment Control, shall be installed and maintained to control and prevent sediment movement. Required locations for silt socks and haybales shall include the following:
   1. All down gradient areas of the site; to protect nearby watercourses and water supply

wells.
2. Along paved areas to prevent sediment movement to the surface of the pavement.
3. All locations dictated by the Owner's representative.

B. Compost Filter Sock and haybales shall be installed prior to site disturbance as required by the contract plans and the owner's representative.
C. Compost Filter Sock and haybales shall be maintained throughout the period of disturbance.
D. Compost Filter Sock and haybales shall be removed following establishment of sufficient vegetation for unpaved areas and after the period of disturbance for paved areas to control and prevent erosion.

3.6 SEDIMENT BASIN:
A. Sediment Basins, as shown or required, shall be as specified in the New York State Standards and Specifications for Erosion and Sediment Control Design Manual, shall be installed and maintained to control and prevent sediment movement.

3.7 DEWATERING ACTIVITIES SEDIMENT CONTROL:
A. All waters which the Contractor pumps from excavations on this project shall be routed through a portable sedimentation tank so as to remove all sediments carried by such water. The tank shall be in accordance with the Standard Specifications included in the New York Guidelines for Urban Erosion and Sediment Control. The tank(s) shall be provided at any and all locations along the trench route/excavation area, as warranted by dewatering activities.

3.8 DUST CONTROL:
A. Activities on this project may create dust from traffic and dry weather conditions. Dust control shall be provided to prevent dust throughout the project in accordance with the Standard Specifications for Dust Control included in the New York Erosion and Sediment Control Design Manual.
B. All pavement and sidewalks in all work areas shall be brush cleaned at the end of each working day to minimize dust potential.

3.9 SOIL RESTORATION:
A. Soil restoration is required where soils have been disturbed for development. Soil restoration is applied in the cleanup and landscaping phase followed by permanent vegetative ground cover. Soil restoration is to be performed in accordance with the NYSDEC Stormwater Management Design Manual Section 5.1.6 and as summarized in the following table:

Soil Restoration Requirements			
Type of Soil Disturbance	Soil Restoration Requirement		Comments/Examples
No soil disturbance	Restoration not permitted		Preservation of Natural Features
Minimal soil disturbance	Restoration not required		Clearing and grubbing
Areas where topsoil is stripped only - no change in grade	HSG A &B	HSG C&D	Protect area from any ongoing construction activities.
	apply 6 inches of	Aerate* and apply 6 inches of topsoil	

Areas of cut or fill	HSG A &B	HSG C & D	
	Aerate and apply 6 inches of	Apply full Soil Restoration **	
Heavy traffic areas on site (especially in a zone 5-25 feet around buildings but not within a 5 foot perimeter around foundation walls)	Apply full Soil Restoration (de-compaction and compost enhancement)		
Areas where Runoff Reduction and/or Infiltration practices are applied	Restoration not required, but may be applied to enhance the reduction specified for appropriate practices.		Keep construction equipment from crossing these areas. To protect newly installed practice from any ongoing construction activities construct a single phase operation sock area
Redevelopment projects	Soil Restoration is required on redevelopment projects in areas where existing impervious area will be converted to pervious area.		

*Aeration includes the use of machines such as tractor-drawn implements with coulters making a narrow slit in the soil, a roller with many spikes making indentations in the soil, or prongs which function like a mini-subsoiler.
** Per “Deep Ripping and De-compaction, DEC 2008”.

3.10 SURFACE RESTORATION:

A. Areas that are disturbed as a result of this project shall be restored. This cover shall consist of grasses or other landscaping pursuant to these specifications.

3.11 EROSION CONTROL DEVICE REMOVAL:

A. Removal of any and all devices used for the purposes of preventing soil runoff shall be removed after suitable vegetation has stabilized the soil.

3.12 CONTRACTOR SITE INSPECTIONS:

A. Inspection Protocol: The Contractor is responsible for conducting and documenting inspections of the construction site(s) once every 7 calendar days and within 24 hours after a rainfall event of 0.5 inch or greater or equivalent snowfall.
B. Inspection Documentation: Use the inspection checklists in Appendix G of the NYS Stormwater Management Manual, latest edition. All inspection checklists shall be turned over to the Owner upon completion of the project.

END OF SECTION 312500

SECTION 321000 - ASPHALT CONCRETE ROADWAY CONSTRUCTION (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Under this item, the Contractor shall perform all work as necessary for the preparation of the roadway as shown on the drawings, called for in the Specifications or as required based on the site conditions. The work shall include, but may not be limited to; subgrade preparation; subbase placement; milling, shaping and removal of portions of existing surfaces; placement of all asphalt concrete pavement courses; and other associated miscellaneous work.

B. Pavement courses shall be hot, plant-mixed asphalt concrete on a prepared base in accordance with these specifications and in reasonable close conformity with the required lines, grades, thickness and typical sections shown on the plans, at the locations shown on the plans.

C. It is the intent of these specifications to obtain a complete and satisfactory roadway structure suitable for urban arterial light industrial use.

D. Generally, asphalt concrete roadway construction will include three (3) pavement courses, base, binder and top. Where the plans call for a two course roadway construction, such roadway will be constructed utilizing a binder and top course, unless specifically noted otherwise. With either roadway configuration, work and materials shall comply with the requirements noted herein, as called for on the plans, and as required by the applicable N.Y.S.D.O.T. Standards.

E. Where applicable, this section shall apply to parking lot and other similar construction, as depicted on the plans.

1.2 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to visit the entire project site and investigate all conditions that may affect his work.

B. The Contractor shall take all necessary as-built measurements and make all necessary investigations in the field, prior to layout of the proposed installation of the work.

1.3 QUALITY ASSURANCE

A. These specifications are to be supplemented by the "Standard Specifications: Construction and Materials" (latest revision) as published by the Office of Engineering, New York State Department of Transportation. All provisions contained in those specifications, relative to quality of construction and materials and execution of the work shall be deemed part of these specifications.

B. The quality of all types of work produced shall be that which can be truly classified as good standard practice in the trade for each respective type of kind of work.

1.4 SUBMITTALS REQUIRED

A. The Contractor shall not deliver nor place any materials, until such time that each material used in the work has been submitted and accepted by the Engineer.

B. Six (6) complete sets of Shop Drawings shall be submitted to the Engineer. The Shop Drawings shall bear the Contractor's stamp of approval indicating that he has reviewed the contents, and that same complies with the Contract requirements.

1.5 Shop Drawing submittals shall conform to the requirements of Section 7.16 of the General Conditions.

PART 2 - MATERIALS

2.1 MATERIAL REQUIREMENTS (GENERAL)

A. Subbase (As Required): Subbase course material will comply with Standard Specifications for Construction Materials, New York State Department of Transportation, Item 304 "Subbase Course" Types 1, 2 or 4 and Technical Specification 02609. The Contractor shall have the subbase material tested for compliance to the Specification requirements and submit the test results to the Engineer for acceptance, at no additional cost to the Owner.

B. Asphalt Concrete: Asphalt concrete materials will comply with Standard Specifications for Construction and Materials, New York State Department of Transportation, Section 403.

C. Tack Coat: Shall comply with Standard Specifications for Construction and Materials, New York State Department of Transportation, Section 407.

2.2 BITUMINOUS TACK COAT

A. The bituminous tack coat shall meet the following requirements:
   1. Comply with NYSDOT Material Designation 702-90.
   2. Shall be an asphalt emulsion tack coat produced by diluting bituminous materials with a suitable emulsifier solution.

B. Tack coat shall not be applied unless the spraying temperature is within the suggested range of 75o F - 150o F.

C. The tack coat shall be sampled and tested in a manner acceptable to the Engineer, at no additional cost to the Owner.

2.3 HOT MIX ASPHALT CONCRETE PAVEMENT

A. All asphalt concrete shall be plant-mixed asphalt concrete prepared in accordance with these Specifications and the related and referenced texts.

B. Binder and top pavements shall be rut avoidance type asphalt concrete.

C. The materials and composition for the mixtures utilized shall meet the requirements for Type 1 base course, Type 3 binder course and Type 6F top course.

D. Unless otherwise called for, base course pavements shall be Type 1 dense base course having an asphalt content of 4.0 - 6.0%. Composition of Type 1 base course (or Type 2, if so called for), shall comply with Table 401-1 of the NYSDOT Standard Specifications.

E. Binder course pavement shall be Type 3 rut avoidance type. Materials and composition for the mixture shall meet the requirements noted in Subsection 401-2.01 through 401-2.05 of the NYSDOT Standard Specifications, except as modified herein.

F. Binder course shall meet the following requirements, except that production tolerance will be permitted to exceed the design general limits, where accepted by the Engineer:

Screen Size	% Passing	Production Tolerance (%)
1-1/2"	100	-
1"	95-100	-
1/2"	58-73	+/- 5
1/4"	38-53	+/- 5
1/8"	26-40	+/- 4
20	9-23	+/- 4
40	4-18	+/- 4
80	3-13	+/- 3
200	2-6	+/- 2
Asphalt Content (%)	4.0-6.0	

G. Top course shall be Type 6F rut avoidance type and shall meet the following requirements:

Screen Size	% Passing	Production Tolerance (%)
1-1/2"	-	-
1"	100	-
1/2"	95-100	-
1/4"	65-85	+/- 5
1/8"	36-65	+/- 4
20	15-39	+/- 4
40	8-27	+/- 4
80	4-16	+/- 3
200	2-6	+/- 2

Asphalt Content (%)	5.4-6.6	

H. Coarse aggregates for binder and top rut avoidance pavements shall be from NYSDOT approved sources and shall meet the high friction requirements. Screened gravel shall not be permitted unless specifically approved. Wappinger Dolomite (as defined by NYSDOT) shall not be permitted. For the Type 6FRA top mix, not less than 20% (by weight) of the total coarse aggregate particles (plus 1/8" material) shall be non-carbonate (as defined by NYSDOT). The coarse aggregates shall be proportioned and blended to provide a uniform mixture.

I. Mix Properties - The mixtures shall meet the marshall property criteria as follows:

Mix Property	Type 3RA	Type 6FRA
Stability, lb., min.	1500	1500
Flow, .01 in., min.	8	8
Marshall Quotient, lb/.01 in., min.	150	150
Air Voids, Percent	3.0-5.0	3.0-5.0
Voids in Mineral Agg. (VMA), Percent min.	13.5	15.5

J. The Marshall specimens shall be prepared, mix properties determined, and completed mix design submitted in accordance with the standard procedures outlined by the N.Y.S.D.O.T. with the following modifications:
   1. Compactive effort shall be 75 blows per side.

K. Five point asphalt cement content Marshall design is required prior to production. One point designs are not acceptable.

L. The minimum specified VMA shall be met at each of the five mix design asphalt cement contents.

M. The marshall quotient is calculated as the corresponding ratio of corrected stability (lbs.) to flow (.01 in.).

N. The optimum asphalt cement content shall be determined by the "Range" method. Graphs shall be constructed for each of the specified mix design properties (stability, Marshall quotient, air voids, and VMA) using each property as the vertical axis and percent asphalt cement content as the horizontal axis. The plotted values in each graph shall be fitted with a smooth curve that obtains the "best fit" for all values. A vertical line is drawn at the point where the asphalt cement content provides the acceptable lower and upper limits for the properties of stability, flow, Marshall quotient, and air voids. The mid-point of the common overlap is the optimum asphalt cement content provided it does not fall on the positive slope of the VMA curve. When this occurs, the low point of the VMA curve shall be the optimum asphalt cement content provided it falls within the common overlap of the specified stability, flow, Marshall quotient, and air voids ranges.

O. Truing and Leveling Course - Where a truing and leveling course is called for, shown or is required based on the conditions, the work shall include placing a course of minimum variable thickness of proper plant mix necessary to bring the surface of the existing pavement to the same transverse slope and longitudinal grade required for the finished pavement course.

P. The work shall consist of removing irregularities in the old pavement, filling and patching holes, correcting variations in banked pavement, establishing pavement crowns, etc. All depressions and wheel path ruts shall be filled prior to the paving of the truing and leveling course.

Q. Asphalt pavement utilized for the truing and leveling course shall be as follows, unless otherwise called for on the drawings:

Compacted Thickness	Type Asphalt Concrete
Up to 1-1/2"	Top - Type 6F(RA)
1-1/2" to 4"	Binder - Type 3(RA)
4" and Greater	Base - Type 1

R. Special attention shall be paid to the proper compaction of thin sections. The surface of this course shall be tested in the same manner prescribed in N.Y.S.D.O.T. Standard Specification paragraph 401-3.14, except that the allowable variation from the true surface after compaction shall not exceed 3/8 inch.

PART 4 - CONSTRUCTION DETAILS

4.1 GENERAL

A. Prior to placement of any subbase the subgrade shall be proofrolled as follows:

4.2 EQUIPMENT

A. he proof roller shall consist of a chariot type rigid steel frame with a box body filled with proofrolling ballast thirty (30) tons gross weight, and mounted on four (4) pneumatic tired wheels acting in a single line across the width of the roller on its transverse load center line. The wheels shall be equipped with 18.00 x 24, or 18.00 x 25,24 ply tires, and shall be suspended on articulated axles such that all wheels carry approximately equal loads when operating over uneven surfaces.

B. Two complete passes of the roller shall be applied over all elements of the area to be proof rolled. Any deficiencies disclosed during the proof rolling operation shall be corrected. Subsidence depressions shall be filled with material similar to the subgrade soil and then compacted in a normal manner. After compaction, these areas shall be proof rolled again. Corrective work shall be judged complete when all elements of the subgrade surface over a given embankment show a satisfactory uniform response to the proof roller, acceptable to the Engineer.

C. The Contractor may propose alternate methods for proofrolling. Any such alternate methods must be as acceptable to the Engineer. The Engineer and Owner reserve the right to require proofrolling in accordance with the provisions noted above, even following the completion of the alternate test method, solely at the Engineer's discretion.

4.3 SUBBASE COURSE

A. Contractor shall lay a foundation course of a compacted depth as shown on the drawings. The laying of this course shall not be allowed if there is any indication of rain, if the ground is wet or will knead under the loaded truck wheels or if there is frost in the ground.

B. In laying the subbase, care is to be exercised to see that it is uniformly spread. After it is leveled and rolled until it does not wave, creep or sag under a ten (10) ton roller, the surface is to be carefully checked to see that the full thickness is laid and to assure that the surface is to grade for the asphaltic concrete pavement. The tolerance for the final grade of the subbase is +/- 1/4".

4.4 WEATHER AND SEASONAL LIMITATIONS

A. Bituminous plant mix shall not be placed on any wet surface or when the surface temperature is less than specified in "Temperature and Seasonal Requirements" or when weather conditions otherwise prevent proper handling or finishing of bituminous mixtures as determined by the Engineer. Top course mixes shall be paved within the seasonal limitations indicated in "Temperature and Seasonal Requirements".

B. Surface temperatures shall, in all cases, be the controlling temperatures at which material is placed. Paving shall be discontinued as soon as the temperature falls below the requirements.

C. The base and binder course shall be covered with a surface (top) course prior to the end of the paving season. If this cannot be accomplished by the Contractor, he shall be solely responsible for any damage to the subbase, base or binder courses. Repairs made to the damaged areas shall be acceptable to the Engineer.

D. Bituminous paving mixtures for driveways, sidewalks, gutters and other incidental construction shall be placed on surfaces having a temperature of 45 degrees Fahrenheit or greater, unless otherwise accepted by the Engineer.

4.5 TEMPERATURE AND SEASONAL REQUIREMENTS

Nominal Compacted Lift Thickness	Surface Temperature Minimum (Note 1)	Seasonal Limits
3" or greater	40 degrees Fahrenheit	None
Greater than 1" but less than 3"	45 degrees Fahrenheit	May 1 to Oct.15
1" or less	50 degrees Fahrenheit	May 1 to Oct.15

Note 1: All temperatures shall be measured on the surface where the asphalt is to be placed and the controlling temperature shall be the average of three temperature readings taken at locations +/- 25 feet apart.

4.6 COLD MILLING OF EXISTING SURFACES

A. Where called for or otherwise required, the work shall include the milling, shaping and removal of portions of existing surfaces by a cold milling process, and

subsequent cleaning, utilizing equipment and procedures meeting the requirements of this specification.

B. The work shall include milling of bituminous or portland cement concrete as shown or called for.

C. Milling machines shall be power operated, self-propelled machines capable of removing the desired thickness of existing surfaces. The machines shall have sufficient power, traction and stability to accurately maintain depth of cut and slope. They shall be capable of producing a finished profile and cross slope to within 1/4 inch of that required and shall produce a uniform surface texture free from gouges and ridges greater than 3/8 inch in depth.

D. The machines shall be equipped with a means to control dust and other particulate matter created by the cutting action. The machines shall have an integral loading system or sufficient equipment shall be provided to accomplish complete removal of milled material at a rate equivalent to the milling rate.

E. Vacuum trucks, street sweepers or power brooms shall be used to clean the milled surfaces. The Engineer may disallow the use of power brooms in urban, residential or other sensitive areas if he deems the dust raised by the broom to be objectionable.

F. All milled material, including that removed by other means, shall be immediately removed from the milled surfaces and adjacent surfaces. When working adjacent to traffic, the Contractor shall immediately remove material that is spilled on the traveled way. Surfaces shall be cleaned of all fines and dust prior to opening to traffic. The Contractor shall conduct his operations in such a manner that dust is controlled and is not objectionable. Milled and adjacent surfaces shall be cleaned again, as directed by the Engineer, prior to the placement of tack coats, or pavement courses if traffic has been allowed on the milled surface and/or if more than 48 hours have elapsed since the initial cleaning. Material removed during the milling process, including foreign debris within or on the pavement, shall become the property of the Contractor and shall be disposed of at a site obtained by the Contractor.

G. Unless otherwise indicated on the plans, profile and cross slope shall be controlled by a taut reference string line. The reference elevation and string line shall be established by the Contractor and subject to the acceptance of the Engineer.

H. Areas not accessible to the milling machine, such as around and/or adjacent to inlets, manholes, curbs and transverse joints on structures, may be removed by a small milling machine, handwork or other methods acceptable to the Engineer.

I. Milled longitudinal or transverse vertical faces exceeding 1-1/4 inches in height that would be exposed to traffic during non-work hours shall be sloped or tapered in a manner so as not to create a traffic hazard. Milling operations shall be conducted to preclude the possibility of pavement runoff collecting along milled joints and creating a traffic hazard. The Contractor shall maintain drainage at catch basins.

J. Milled surfaces to be overlayed with asphalt concrete shall be covered with at least a single course of asphalt concrete before the end of the paving season. Portland cement concrete overlays shall be completed over milled surfaces before the end of the paving season. Damage to milled surfaces resulting from traffic or other causes such as, but not limited to, raveling, fuel spillage or any contaminants which would inhibit bond, shall be repaired or remilled by the Contractor to the satisfaction of the Engineer.

4.7 HAULING EQUIPMENT

A. The mixture shall be transported from mixing plants to the work site in tight vehicles having clean and smooth metal beds. Each load shall be covered with canvas or other suitable material of such size as to protect the mixture from the weather. When necessary, so that the mixture will be delivered on the road at the specified temperatures, truck bodies shall be properly insulated.

B. The inside surface of the vehicles used for the transportation of plant mixes shall be lightly coated, just before the vehicles are loaded, with either a whitewash of lime and water, soap solutions or detergents.

C. After application, the truck bodies shall be raised for a sufficient time to allow the excess fluid to drain.

4.8 PREPARATION OF EXISTING PAVEMENT

A. Existing pavement and shoulder surfaces to be overlaid, including ruts and depressions, shall be cleaned by the use of mechanical sweepers, hand brooms, or other effective means until the surfaces are free of all material which might interfere with the bond between the overlay material and the existing surfaces. All cleaning equipment shall be accepted by the Engineer prior to use. Cleaning shall continue until adequate cleaning results, as acceptable to the Engineer.

B. All debris shall be removed from the pavement and shoulders surfaces and disposed of in a manner acceptable to the Engineer. The pavement and shoulders shall be kept clean until the overlay operations are completed. Cleaning of shoulders is required only when the shoulder surface is constructed of Portland Cement, asphalt concrete or a surface treatment thereon.

C. All unsealed and inadequately sealed joints and cracks, in the opinion of the Engineer, shall be subjected to a compressed air stream of at least 80 p.s.i.g. measured at the source. Joints and cracks in the pavement as identified by the Engineer, shall be cleaned of all dirt and loose material holding the cleaning jet 1 inch above the pavement surface. Old joint and crack sealer remaining after such cleaning operation need not be removed. The cracks shall be kept clean until the sealing, filling and paving operations are completed. Joints and cracks in the existing pavement from 1/4 inch to 1 inch wide shall be sealed with a bituminous material meeting the requirements of Asphalt Filler in the N.Y.S.D.O.T. Standard Specifications. To insure that space will be available for expansion of the asphalt when the hot bituminous mixture is paved over the joint or crack, the joint or crack shall not be filled completely to the surface. Blotting with fine aggregate shall be provided if, in the opinion of the Engineer, same is necessary to prevent tracking the bituminous material over the pavement surface.

D. Joints and cracks greater than 1 inch wide shall be filled with asphalt concrete meeting the requirements of Section 401 of the N.Y.S.D.O.T. Standard Specifications. Alternate materials may be used subject to the acceptance of the Engineer. Joints and cracks less than 1/4 inch will not be required to be cleaned or sealed.

E. Work on joints and cracks shall not begin until all stress relieving pavement repairs have been completed.

4.9 TACK COAT

A. For all areas where existing bituminous or portland cement concrete surfaces are called for to be properly prepared, or where new pavement courses are to be placed over such existing surfaces, the work shall include application of a bituminous tack coat in accordance with these specifications.
B. Bituminous tack coat shall comply with requirements for "Asphalt Emulsion for Tack Coat", Section 702-90, of the N.Y.S.D.O.T. Standard Specifications.
C. The Contractor shall provide a distributor for applying the tack coat. The distributor shall be designed, equipped, maintained and operated so that the tack coat can be heated and applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.03 to 2.0 gallons per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard. Distributor equipment shall include a tachometer, accurate metering device or a calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically.
D. The tack coat shall be uniformly applied by a pressure distributor to a prepared clean pavement. The tack coat shall be applied to cause the least inconvenience to traffic and to permit one-way traffic, where practical, to prevent pickup or tracking of the bituminous material.
E. Tack coat shall not be applied on a wet pavement surface or when the surface temperature is below 45o F. The temperature and areas to be treated shall be accepted by the Engineer prior to application. The application rate shall be 0.05 gallons per square yard (minimum), or as otherwise accepted by the Engineer.

4.10 BITUMINOUS PAVERS

A. Bituminous pavers shall be self-powered with an activated screed or strike-off assembly. The machine shall be capable of spreading and finishing courses of bituminous plant mix material in lane widths applicable to the specified typical section and thicknesses shown on the plans. Pavers used for shoulders and similar construction shall be capable of spreading and finishing courses of bituminous plant material in widths shown on the plans. The paver shall have a receiving hopper with sufficient capacity for uniform spreading operation and with automatic flow controls to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture. When laying mixtures, the paver shall be capable of operating at forward speeds consistent with satisfactory placement of the mixtures.
B. All bituminous pavers, used to place base, binder and surface courses shall be equipped with automatic transverse slope and longitudinal grade screed controls. The controls shall automatically adjust the screed and increase or decrease the mat thickness to compensate for irregularities that are in the surface being paved. The controls shall be capable of maintaining the proper transverse slope and be readily adjustable so transitions and super elevated curves can be satisfactorily paved. The controls shall operate from suitable fixed or moving references as prescribed in "Spreading and Finishing", hereinafter. Widths in excess of seventeen (17) feet shall have approved automatic transverse slope and longitudinal grade screed controls that operate from references on both sides of the paver.

C. The transverse slope and longitudinal grade screed controls of the bituminous paver may be manually adjusted, where acceptable to the Engineer, according to the requirements of "Spreading and Finishing" hereinafter. Any paver in the sole opinion of the Engineer to be found worn or defective at any time shall immediately be prohibited from use on the project until such time as repairs have been made to the satisfaction of the Engineer and at no additional cost to the Owner.

4.11 ROLLERS

A. Rollers shall be either a vibratory or static steel wheel or pneumatic tire type in good mechanical condition free from excessive backlash and capable of operating at speeds slow enough to avoid displacement of the bituminous mixture. The number and weight of rollers shall be sufficient to satisfactorily compact the mixture while it is still in a working condition. The use of equipment which results in excessive crushing of aggregate will not be permitted.

B. Vibratory rollers shall be on the current NYSDOT approved list - Bituminous Concrete Vibratory Compaction Equipment. The use of vibratory compaction equipment shall be at the Contractor's own risk. The Contractor shall be fully responsible for the cost of repairing all damages which may occur to highway components and adjacent property caused by vibratory equipment.

C. Steel rollers shall be self-propelled and be either of the 10-12 ton tandem three-axle type, or 8-10 ton tandem two-axle type.

D. Pneumatic rubber-tired rollers shall be self-propelled and consist of two axles on which are mounted multiple pneumatic-tired wheels in such a manner that the rear wheels will not follow in the tracks of the forward wheels and will be spaced to give essentially uniform coverage with each pass. The axles shall be mounted in a rigid frame provided with means for adding ballast. Wheels shall be so mounted as to oscillate individually or in pairs. The tires shall be smooth and show no tread pattern, be of equal size and diameter, and be uniformly inflated. Pneumatic rollers shall not be utilized for compaction of the top course of pavement either vibratory or static steel wheel roller must be used. Pneumatic rollers shall meet the following requirements:

Maximum Wheel Load	5,600 pounds
Tire Compression on Pavement	80 p.s.i. +/- 5 p.s.i.
Maximum Axle Load	22,400 pounds

Alternate types of rollers may be acceptable to the Engineer, if field tests or other data demonstrates that satisfactory results can be achieved.

4.12 SPREADING AND FINISHING

A. Base and binder course material may be delivered from more than one plant provided that no placing or compaction difficulties are evident to the Engineer. The delivery of top course material from two or more plants, in alternate deliveries to the same spreader, will not be permitted unless both the same aggregate source and job mix formula are used by all plants.

B. The mixture shall be laid upon an acceptable clean, dry surface, spread and struck off to the established grade and elevation. Acceptable bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width

as may be practicable. Bituminous pavers shall be in the charge of an experienced operator. Placing of the mixture shall be continuous at a desired rate of not less than fifty (50) tons per hour. The Engineer may permit a lesser rate, if satisfactory results are achieved. Upon arrival at the site, the mixture shall be dumped into the paver and immediately spread and struck off to the width required and to such appropriate loose depth that when the work is completed, the required compacted thickness of mixture will be obtained. The depth of any one course of plant mixed material shall not be greater than that necessary to produce a compacted thickness of four (4) inches.

C. For the initial pavement course laid with automatic bituminous pavers, the paver shall be guided by a taut reference line positioned at or near the pavement centerline or edge. The reference line shall be supported at approximately twenty-five (25) feet intervals on tangent sections and at closer intervals on curves. The line shall be tensioned sufficiently to remove any sags.

D. The Contractor shall erect and maintain the reference line to the satisfaction of the Engineer. A moving reference of at least thirty (30) feet in length, such as a floating beam, ski, or other suitable type may be substituted for the reference line if the surface to be paved is sufficiently even and satisfactory results can be achieved. A short ski or shoe may also be used for the initial course, if a satisfactory fixed reference, such as a curb, gutter or other fixed reference, is adjacent to the pavement.

E. Subsequent pavement courses placed over the initial course can be placed using a suitable fixed reference or by a moving reference having a minimum length of thirty (30) feet. Any course in an adjacent lane may be used as a reference line for a short ski, or other similar device.

F. The automatic screed controls will not be required where existing grades at roadway intersections or drainage structures must be met, for shoulders, temporary detours, behind curbs, or in other areas where its use is impractical as determined by the Engineer.

G. If the areas to be paved are small and scattered, a paver may be dispensed with and the course spread by hand methods as acceptable to the Engineer. For such areas, the mixture shall be dumped, spread and screeded to give the required section and compacted thickness.

H. Before any rolling is started, the loose mat shall be checked, any irregularities adjusted, and all unsatisfactory material shall be removed and replaced.

4.13 COMPACTION

A. Immediately after the bituminous mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. The surface shall be rolled when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving.

B. During the initial rolling, a static roller with a minimum weight of 8 tons shall travel parallel to the center line of the pavement beginning at each edge and working toward the center, overlapping on successive trips by one half the width of the roller. Banked curves shall be rolled starting at the low side edge and working toward the superelevated edge.

C. Rollers shall move at a slow and uniform speed, not exceeding 2.5 miles per hour. The roller drive roll or wheel shall be nearest the paver.

D. Any displacement occurring as a result of reversing the direction of a roller, or from other causes, shall be corrected at once by the use of rakes and addition of fresh mixture where required. Care shall be exercised in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the rollers, the wheels shall be kept properly moistened with water or water mixed with small quantities of detergent. In no case shall a solvent having affect upon bituminous material be used.

E. The Contractor shall provide a combination of the rollers and utilize one of the options in Section 401-3.12 of the NYSDOT Standard Specifications.

F. Along forms, curbs, headers, walls and other areas not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers as accepted by the Engineer. On depressed areas, a trench roller may be used or cleated compression strips may be used under the roller to transmit compression to the depressed area.

G. Suitable means shall be provided to keep the pavers, other equipment and tools free from bituminous accumulations. The surface of the pavement shall be protected from drippings of oil, kerosene, or other materials used in paving, and cleaning operations.

H. The Contractor may be required to adjust and change both equipment and compaction procedure if in the sole opinion of the Engineer insufficient compaction is being achieved.

I. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of the bituminous material shall be corrected to the satisfaction of the Engineer. If in the sole opinion of the Engineer, an unsatisfactory area that develops during the life of the contract, the area shall be removed and replaced with suitable material at the expense of the Contractor.

4.14 CONDITIONING OF EXISTING SURFACE

A. The surface of the existing pavement shall be cleaned, joints and cracks filled, and the surface leveled to a uniform grade and cross slope in all areas prior to the application of a new bituminous concrete course. The surface shall be cleaned and the joints and cracks filled to the satisfaction of the Engineer. The expense for cleaning foreign material from the pavement shall be borne by the Contractor. Leveling of the surface shall be in conformance with the requirements stated below.

B. Contact surfaces between bituminous mixtures and Portland Cement concrete such as adjacent pavement, edges, existing pavement, curbing, gutters, manholes and other structures shall be painted with a thin, uniform coating of bituminous material prior to the bituminous mixture being placed against them.

4.15 JOINTS

A. The finished pavement at joints shall comply with surface smoothness requirements and exhibit the same uniformity of texture and compaction as other sections of the course. Rollers shall not pass over the unprotected edges of a freshly laid mixture.

B. In the formation of all joints, the exposed edge of the existing layer that will become part of the joint shall be the full thickness of the layer and straight. If the existing edge is unacceptable to the Engineer, the edge shall be corrected by using a power

driven saw or other acceptable tools to cut a neat line at the expense of the contractor. A light coat of bituminous material shall be applied to existing pavement edges in order to provide bond with the newly laid pavement.

C. Transverse - The placing of the course shall be as continuous as possible. The joint shall be formed by cutting back on the previous run to expose the full depth of the course.

D. Longitudinal - Longitudinal joints in the surface course shall correspond with the edges of proposed traffic lanes unless otherwise accepted by the Engineer. When traffic is maintained on the roadway during paving operations, the mixture shall be laid such that no more than 100 feet of pavement edge will be exposed at the end of the working day. The Engineer may permit an exposed edge of this type in excess of 100 feet providing that the edge is adequately protected against damage by vehicles and equipment.

4.16 SURFACE TOLERANCE

A. The pavement surface shall be tested in the presence of the Engineer with a sixteen (16) foot straight-edge or string line placed parallel to the centerline of pavement and with a ten (10) foot straight-edge or string line placed transversely to the centerline of pavement on any portion of the pavement surface. Variations exceeding 1/4" shall be satisfactorily corrected or the pavement relaid at no additional cost to the Owner. The Contractor shall supply the materials and labor as necessary to perform this test in the presence of the Engineer at no additional cost.

4.17 THICKNESS TOLERANCES

A. The thickness indicated for each of the various courses of bituminous pavement is the nominal thickness. The pavement shall be so constructed that the final compacted thickness is as near to the nominal thickness as is practical and within the tolerances specified below.

B. Cores shall be performed at a minimum of every 350 feet in a location selected by the Engineer.

C. Determinations for final acceptance and pavement will be made from cores or thickness measurements taken on the completed pavement. The Contractor shall fill all core holes with bituminous concrete and compact the mixture in a manner acceptable to the Engineer. The cost of all testing and associated work shall be at the Contractor's expense.

D. A tolerance not to exceed minus (-) 1/4" from nominal thickness required for the course specified will be acceptable where the required nominal thickness is four (4) inches or less. A tolerance not to exceed minus (-) 1/2" from the nominal thickness required for the course or courses specified will be acceptable where the required nominal thickness is over four (4) inches. In addition, the sum total thickness of all bituminous mixture courses shall not vary from the total of the nominal thickness indicated on the plans by more than minus (-) 1/4" where the total nominal thickness is eight (8) inches or less; or more than minus (-) 1/2" where the total nominal thickness is more than eight (8) inches.

E. No payment will be made for any extra thickness placed over and above the permissible tolerance.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. The unit of measurement shall be the square yards of roadway constructed. Payment will be made for the number of square yards of roadway constructed at the unit price under the appropriate item in the proposal. These prices shall include furnishing of all materials, removal of existing pavement and excavation of all materials to the subgrade, subbase placement, cold milling, cleaning of all pavement surfaces prior to pavement application, tack coat, asphalt concrete placement, compaction required and all work incidental thereto, including the necessary testing, complete.

4.2 PAVEMENT

A. Pavement placement shall be made and paid for under this item only for those sections contained within the payment limits shown on the contract plans. All pavement, which is disturbed by the Contractor due to his operations, other than where shown on the plans or indicated in writing by the Engineer, shall be replaced in accordance with these specifications at the Contractor's expense.

END OF SECTION 321000

SECTION 321613 - CONCRETE CURB

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Place concrete curbs at the locations shown on the Plans including the excavation and removal of existing items where encountered.
B. Curbs to be of the type shown on the Plans complete with all special configurations indicated, called for or required.
C. Provide Foundation Material (Run-of-Bank unless other type is specifically called for) to the minimum requirements indicated for proper placement of the curbs.
D. Restoration of the adjoining areas if not specifically covered under another item.

1.2 RELATED WORK

A. Roadway Subbase course - Section 321116
B. Trenching, Backfilling and Compaction - Section 312333
C. Asphalt Concrete Roadway Construction – Section 321000
D. Cast-In-Place Concrete - Section 033000

1.3 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 GENERAL

A. All curbs shall be cast in-place, of the type and dimensions shown on the Plans and/or details.
B. Curbs shall be of "Class A Concrete", unless otherwise noted, and shall conform to all the specific requirements of that section.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL

A. Curbs shall be cast in-place, at the locations and grades required by the Drawings.
B. Shall have sections no greater than fifteen (15) feet in length. In curved areas joints shall be more closely spaced as acceptable to the Engineer. However, all joints shall maintain the same spacing throughout the entire project.
C. Shall have provisions at each joint for expansion of 1/2".
D. One-half inch (1/2") expansion joint material shall be premoulded bituminous cut to conform with the cross-section of the curb.

3.2 FORMS

A. All forms shall be set true to line and grade and held rigidly in position.
B. They shall be either metal or of acceptable plan and matched lumber, and of such construction that there will be no interference to the inspection of grade and alignment and that a smooth surface will be provided.
C. Forms shall be left in place at least twenty-four (24) hours or until the concrete has set sufficiently in order that, in the opinion of the Engineer, they can be removed without injury to the curb.
D. Upon removal of the forms, the curb shall be immediately rubbed down to a smooth and uniform surface, but no plastering will be permitted.
E. For this work, competent and skillful finishers shall be employed.

3.3 PLACEMENT OF CONCRETE

A. Placement and handling of concrete shall comply to the requirements of Specification Section, "Class A Concrete".
B. The concrete shall be compacted by means of an acceptable immersion type, mechanical vibrator of a size and weight sufficient to thoroughly vibrate the entire concrete mass without damaging or misaligning the forms.
C. The vibrator shall be introduced into the concrete at one foot intervals for a period not to exceed two seconds for each immersion and shall vibrate at not less than 5000 impulses per minute.

3.4 CURING

A. At the Contractor's option, either waterproof paper blankets, quilted covers, polyethylene coated burlap blankets or polyethylene curing covers shall be used in curing concrete curb.
B. Other methods of curing may be used only when so indicated on the plans or acceptable to the Engineer.
C. The method of curing shall comply with the requirements of "Class A Concrete".

3.5 PROTECTION

A. The Contractor shall protect the curb and keep it in alignment and first class condition until the completion of the Contract.
B. Any curb, which is damaged or substandard in the sole opinion of the Engineer at any time prior to the final acceptance of the work, shall be removed and replaced with satisfactory curb at the Contractor's expense.

3.6 COORDINATION WITH DRAINAGE REQUIREMENTS

A. It is the intent of this specification to provide a completed work which properly coordinates the pavement replacement work in such a way as to promote proper drainage to adjacent stormwater catch basins, if existing or to be installed.
B. Where on the plans the term "gutter" is referenced with regards to the curb or pavement replacement area, special controlled grade placement in accordance with Section 02616 shall be understood.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement will be made on the basis of lineal footage of curb placed in accordance with the plans and specifications, as measured by the Engineer.

4.2 PAYMENT

A. Payment will be made at the unit price bid under the "Concrete Curb" Item of the Proposal; the price bid per lineal foot shall include excavation, preparing subgrades, foundation material, all necessary forms, concrete, expansion joints, backfill, labor and equipment as necessary for the complete installation.

B. In the case where existing curb must be removed for the installation of the concrete curb, the cost for same shall be deemed included in the unit price bid for the Concrete Curb Item; no separate payment will be made for removal of the existing curbs.

C. Where no separate item for payment is included in the Proposal, the work required under this Section shall be provided, with the payment deemed included under the other item of the Proposal.

END OF SECTION 321613

SECTION 321623 – CONCRETE SIDEWALKS (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This work shall consist of furnishing and placing Portland cement concrete for sidewalks and other exterior improvements, including furnishing and setting of all reinforcing rods as indicated on the plans and in accordance with the specifications.

1.2 RELATED WORK

A. Earthwork: Section 310000

1.3 REFERENCES

A. American Concrete Institute, ACI 301, latest edition, Specification for Structural Concrete
B. American Concrete Institute, ACI 117, latest edition, Specification for Tolerances for Concrete Construction and Materials
C. New York State Department of Transportation Standard Specifications (US Customary Units)

1.4 SUBMITTALS

A. Product Data
   1. Concrete Design Mix: Submit proposed concrete design mix together with name and location of batching plant at least 28 days prior to the start of concrete work.
   2. Portland Cement: Brand and Manufacturer's name.
B. Aggregate: Gradation and Source
   1. Air-entraining Admixture: Brand and manufacturer's name.
   2. Water-reducing or High Range Water-reducing Admixture: Brand and manufacturer's name.
   3. Curing Compound: Manufacturer's specifications and application instructions.
   4. ADA Detectable Warning Surface: Manufacturer's specifications, product data, test reports, method of installation, and maintenance instructions.

1.5 QUALITY ASSURANCE

A. Concrete batching plants shall be currently approved as concrete suppliers by the New York State Department of Transportation.

1.6 DELIVERY

A. Batch Ticket Information: Indicate on the delivery ticket the type, brand, and amount of fibrous concrete reinforcement material added to each batch of concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The Portland cement concrete shall consist of a homogeneous mixture of cement, water, fine aggregate, course aggregate, and admixtures proportional and mixed according to ACI Code of latest edition and these specifications.
   1. Design Air Content: ASTM C260, and on the New York State Department of Transportation's current "Approved List"; 7.5 percent by volume plus or minus 1.5 percent.
   2. Cement: ASTM C150 Type II Portland cement. Minimum 725 pounds per cubic yard.
   3. Water: Potable. Max w/c ratio shall be 0.44
   4. Slump: Maximum 3.5 inches; minimum 2.5 inches before the addition of any water-reducing admixtures or high-range water-reducing admixtures (superplasticizers) at the site. Except when a water-reducing admixture is used, maximum slump shall be 6 inches and when a high range water reducing admixture is used maximum slump shall be 8 inches.
   5. Water-reducing Admixture: ASTM C494, Type A, and on the New York State Department of Transportation's current "Approved List".
   6. High Range Water-reducing Admixture: ASTM C494, Type F, and on the New York State Department of Transportation's current "Approved List".
   7. Retarding Admixture: ASTM C494, Type D, Water-reducing and retarding, for use in hot weather concreting, and on the New York State Department of Transportation's current "Approved List".

B. Coarse Aggregate. ASTM C33 Number 7. Coarse aggregate shall be crushed stone, crushed gravel or crushed slag. This aggregate shall be clean and uncoated and meet the following gradation requirements:

Sieve Size	% Passing by Weight
1 1/2"	-
1"	100
1/2"	90 - 100
1/4"	0 - 15

C. Chemical Curing: ASTM C309, Type 1D or 2, Class B, and on the New York State Department of Transportation's current "Approved List" No thinning of material allowed. The volatile organic compound (VOC) content of concrete curing compounds shall meet requirements of the EPA national AIM VOC regulations.

D. Bar Reinforcement: ASTM A615, Grade 60, deformed steel bars.

E. Welded Wire Fabric: ASTM A1064, except welded intersections shall be spaced not farther apart than 12" in the direction of principle reinforcement.

F. Bar Supports: Galvanized steel or AISI Type 430 stainless steel, and without plastic tips.

G. Tie Wire: Black annealed wire, 16-1/2 gage or heavier.

H. Type 1 Expansion Joint Filler: Preformed, resilient, non-extruding cork units complying with ASTM D1752, Type II.

I. Type 3 Expansion Joint Filler: Preformed, resilient, non-extruding bituminous units complying with ASTM D1751.

J. Reinforcement Fiber: Synthetic, fibrillated fibers, specifically engineered and manufactured for use as secondary concrete reinforcement meeting ASTM C1116 Type III.

K. ADA Detectable Warning Surface: Precast or prefabricated paving units or detectable Warning plate with a non-slip texture on the travel surface. Color shall be a shade of brick red. There shall be a minimum of 70 percent 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. Detectable Warning Plate Model R-4984 by Neenah Foundry, 2121 Brooks Avenue, Neenah, WE 54956, (800) 558-5075, www.nfco.com.
   2. ADA Pavers by Whiteacre-Greer, 1400 S. Mahoning Avenue, Alliance, OH 44601, (800) 947-2837, www.wgpaver.com.
   3. Detectable Warning Surface System by Detecto-Tile, 10133 State Highway 7, Worcester, NY 12197, (607) 397-9381, www.detectotile.com.
   4. Classic Dot Detectable Warning Pavers by Oaks Concrete Products, 1900 Vulcan Blvd., Bartlett, IL 60103, (800) 263-4162, www.oakspavers.com.
   5. Granite Truncated Dome Pavers by Cold Spring Granite Company, 202 S. Third Avenue, Cold Spring, MN 56320-2593, (800) 551-7502, www.coldspringgranite.com.

2.2 JOINTS AND EMBEDDED ITEMS (AMENDMENTS TO ACI 301, SECTION 5.3.2.6):
A. Obtain bond at construction joints by the use of epoxy bonding agent (adhesive) or the use of cement grout.

PART 3 - EXECUTION

3.1 PREPARATION
A. Do not use items of aluminum for mixing, chuting, conveying, forming, or finishing concrete. Magnesium alloy tools may be used for finishing.
B. Set forms true to line and grade and anchor rigidly in position.
C. Space expansion joints equally at not more than 20’-0” on center unless otherwise indicated. Place expansion joints to isolate sidewalk from other structures and fixed objects.
D. Place joint filler at expansion joints and where new concrete abuts existing concrete paving and 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.

3.2 USE OF FIBER REINFORCEMENT
A. Add required amount of fibrous concrete reinforcement to the concrete and mix in accordance with fiber manufacturer’s batching and mixing instructions.
B. Fibers shall be uniformly dispersed in the concrete, and concrete shall be free of fiber balls or lumps when discharged at the Site.

3.3 PLACING STEEL REINFORCEMENT (AMENDMENTS TO ACI 301, SECTION 3)
A. At the time concrete is placed, reinforcement shall be free of mud, oil, loose rust, loose mill scale, and other materials or coatings that may adversely affect or reduce the bond.
B. Unless otherwise shown differently on the Drawings, all reinforcement to be placed per ACI 301-05.

3.4 PLACING CONCRETE

A. 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.
B. Locate construction joints, if any, at expansion joints.

3.5 PLACING ADA DETECTABLE WARNING SURFACE

A. The ADA detectable warning surface shall be installed 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 in accordance with the manufacturer's printed instructions.
D. The curb, ADA detectable warning surface, and sidewalk shall be flush with the elevation of the road surface.

3.6 FINISHING AND CURING

A. Wait until bleeding is stopped before final finishing operations.
B. Keep surface damp but not wet between initial strike off and final finish.
   1. Utilize a fog spray, evaporative inhibitor, or midrange water reducer that is compatible with supplementary cementing materials to help control the amount of surface drying of the fresh concrete.
C. Minimize working of the surface during finishing.
D. Utilize a magnesium or wood float.
E. Avoid the use of steel finishing trowels and utilize a concrete finishing machine when possible.

3.7 EXPANSION AND CONTROL JOINTS

A. Saw control joints (CJ) one inch deep after the concrete has set. Complete saw cuts within 18 hours after slab is placed. Space control joints equally between expansion joints at approximately 5'-0" on center, except where a different spacing is shown on the drawings.
B. Provide tooled control joints one inch deep. Space control joints equally between expansion joints approximately 5'-0" on center, except where a different spacing is shown on the drawings.
C. Finish edges of walk and expansion and control joints with a 1/4-inch radius edging tool.
D. Provide broom finish for walk surfaces.
E. Apply curing compound immediately after final finish. Application shall be in accordance with the manufacturer's printed instructions.
F. Expansion joints shall be remolded ½" thick placed to full depth of concrete

3.8 HOT AND COLD WEATHER CONCRETING

A. Comply with ACI 305R whenever the atmospheric temperature or the form surface temperature is at or above 90 degrees F., or climatic conditions of wind and/or low humidity will cause premature drying of the concrete during the protection period.

B. Comply with ACI 306R whenever the atmospheric temperature or the form surface temperature is at or above 40 degrees F., or climatic conditions of wind and/or low humidity will cause premature drying of the concrete during the protection period.

3.9 PROTECTION

A. The Contractor shall protect the concrete from any pedestrian traffic or other incidental damage until the completion of the Contract.

B. Any sidewalk, ramp, curb or driveway apron which is damaged or substandard in the sole opinion of the Engineer at any time prior to the final acceptance of the work, shall be removed and replaced with satisfactory curb at the Contractor's expense.

3.10 FIELD QUALITY CONTROL

A. Special Inspections:
   1. The contractor shall engage a qualified testing and inspecting agency, at contractor’s expense, to perform tests and inspections and to submit reports as outlined in section 3.12.B through 3.12.E

B. Testing Agency:
   1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
   2. Testing agency shall immediately report to Engineer, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
   3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
      a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
         1). Project name.
         2). Name of testing agency.
         3). Names and certification numbers of field and laboratory technicians performing inspections and testing.
         4). Name of concrete manufacturer.
         5). Date and time of inspection, sampling, and field testing.
         6). Date and time of concrete placement.
         7). Location in Work of concrete represented by samples.
         8). Date and time sample was obtained.
         9). Truck and batch ticket numbers.
         10). Concrete mixture designation, proportions, and materials.
         11). Field test results.

C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.

D. Inspections: Required inspections to be performed by qualified testing agency.
   1. Verification of use of required design mixture.
   2. Concrete placement, including conveying and depositing.

3. Curing procedures and maintenance of curing temperature.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C172/C172M shall be performed in accordance with the following requirements:

F. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

G. Slump: ASTM C143/C143M:
   1. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   2. Perform additional tests when concrete consistency appears to change.

H. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete; ASTM C173/C173M volumetric method, for structural lightweight concrete.
   1. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

I. Concrete Temperature: ASTM C1064/C1064M:
   1. One test hourly when air temperature is above 40 deg F and below or 80 deg F and above, and one test for each composite sample.

J. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
   1. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

K. Test results shall be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor within 48 hours of testing.

L. Additional Tests:
   1. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer.
   2. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
      a. Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.

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

N. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 321623

SECTION 323113 – CHAIN LINK FENCE

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 General Requirements apply to this section.

1.2 SUMMARY

A. This Section includes fence framework, fabric, gates, steel posts and channels as shown on the Contract Drawings, complete with accessories.

1.3 REFERENCES

A. Materials and installation shall be in accordance with the latest revisions of the following codes, standards and specifications, except where more stringent requirements have been specified herein:

1. American Society for Testing and Materials (ASTM)

a. A90 Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles

b. A121 Specification for Zinc-Coated (Galvanized) Steel Barbed Wire

c. A392 Specification for Zinc-Coated Steel Chain-Link Fence Fabric

d. A428 Test Method for Weight of Coating on Aluminum-Coated Iron or Steel Articles

e. A491 Specification for Aluminum-Coated Steel Chain-Link Fence Fabric

f. A569 Specification for Steel, Sheet and Strip, Carbon (0.15 Maximum Percent). Hot-Rolled, Commercial Quality

g. A585 Specification for Aluminum-Coated Steel Barbed Wire

h. A817 Specification for Metallic-Coated Steel Wire for Chain-Link Fence Fabric

i. A824 Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence

j. B117 Method of Salt Spray (Fog) Testing

k. C94 Ready-Mixed Concrete

l. F567 Standard Practice for Installation of Chain-Link Fence

m. F626 Specification for Fence Fittings

n. F669 Standard Specification for Strength Requirements of Metal Posts and Rails

o. F083 Standard Specification for Pipe, Steel and Hot Dipped Zinc Coated, Welded, for Fence Structures

1.4 SUBMITTALS

A. In addition to those submittals identified in the General Provisions, the following items shall be submitted:

1. Manufacturers certification that all materials furnished are in compliance with the applicable requirements of the referenced standards and this specification.

B. Samples of any material shall be submitted at the Engineers request.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. The following manufacturers are named to establish a standard of quality necessary for the Project.

1. Allied Tube & Conduit Corp.
2. Anchor Fence, Inc.
3. Page Aluminized Steel Corp.
4. Master Halco, Inc.
5. Or equal

2.2 GENERAL

A. Framework: Type I or Type II Steel Pipe.

1. Type I - Schedule 40 steel pipe with 1.8 ounces of zinc coating per square foot of surface area conforming to Standard Specification ASTM F1083; or

2. Type II - pipe manufactured from steel conforming to ASTM A 569 or F 669, cold-formed, high frequency welded and having a minimum yield strength of 50,000 PSI. External surface triple coated with 1.0 ounce +- 0.1 ounce

of zinc per square foot, 30 +- 15 micrograms of chromate per square inch and 0.5 +- 0.2 mils of clear, cross linked polyurethane. Internal surface coated, after welding, with a zinc-rich based organic coating having an 87% zinc powder loading capable of providing galvanic protection.

3. Pipe shall be straight, true to section and conform to the following weights:

Pipe Size Outside Diameter	Type I Weight Lbs./Ft.	Type II Weight Lbs./Ft.
1 5/8"	2.27	1.84
2"	2.72	2.28
2 1/2"	3.65	3.12
3"	5.79	4.64
3 1/2"	7.58	5.71
4"	9.11	6.56

4. Channel shall be Unistrut, model P1001A, 1 ⅝” x 3 ¼”, 12 ga. galvanized steel channel, or approved equal.

B. Fittings:

1. Pressed steel or cast iron, galvanized with a minimum of 1.2 ounces of zinc per square foot of surface area, or cast aluminum alloy, all conforming to ASTM F 626.

2.3 CONCRETE MIX

A. ASTM C 94 Portland Cement concrete with maximum 3/4" aggregate having a minimum compressive strength of 2,500 PSI at 28 days.

2.4 MATERIALS AND CONSTRUCTION

A. Fence Posts

1. Fence posts shall be sized as follows:

Fabric Height	Line Post O.D. Type I	Line Post O.D. Type II	Terminal Post O.D. Type I	Terminal Post O.D. Type II
Under 6'	2"	2"	3"	2 1/2"
6' to 9'	2 1/2"	2 1/2"	3"	3"
9' to 12'	3"	3"	4"	3 1/2"

B. Gate Mounting Posts

1. Gate mounting posts shall be sized as follows:

Single Gate Width	Double Gate Width	Post O.D. Type I	Post O.D. Type II
Up to 6'	Up to 12’	4"	3”
7' to 12'	13' to 25'	4"	3.5"
13' to 18'	25' to 36'	6 5/8"	---

C. Rails and Braces

1. Rails and braces shall be 1 5/8" O.D., Type I or Type II.

D. Fabric

1. Fabric shall be black vinyl-coated steel wire, 9 gage, woven in a 2-inch diamond mesh with top knuckled selvage twisted and barbed and bottom selvage knuckled. Fence heights up to 12 feet shall be one-piece widths.

E. Swing Gates

1. Gates shall have frame assembly of 2 inches O.D., Type I or Type II pipe with welded joints. Weld areas repaired with zinc-rich coating applied per manufacturer's directions. Fabric shall match fence. Gate accessories, hinges, latches, center stops, keepers and necessary hardware shall be of quality required for industrial and commercial application. Latches shall permit padlocking of gate.
2. Hinges: Heavy duty, non-lift type, offset to permit 180 degree swing and of suitable size and weight to support the gate.
3. Latching: ADA type latch with padlock eye for single gates. Padlock eye shall be an integral part of the latch construction. Latch shall be installed 34”min.-48”max. above finish grade measured vertically.
4. Gate Surfaces: Swinging door and gate surfaces within 10 inches of the finish floor or ground measured vertically shall have a smooth surface on the push side extending the full width of the door or gate. Parts creating horizontal or vertical joints in these surfaces shall be within 1/16 inch (1.6 mm) of the same plane as the other. Plate shall be min. 14GA galvanized steel, welded to gate assembly for full width of gate.

F. Channels

1. Channel shall be Unistrut, model P1001A, 1 ⅝” x 3 ¼”, 12 ga. galvanized steel channel, or approved equal.

G. Fittings

1. Post caps shall be pressed steel, cast iron or cast aluminum alloy designed to fit snugly over posts to exclude moisture. Supply cone type caps for terminal posts and loop type for line posts.

2. Rail and brace ends shall be pressed steel, cast iron or cast aluminum alloy, cup-shaped to receive rail and brace ends.

3. Top rail sleeves shall be tubular steel, 0.051 thickness by 7 inches long, expansion type.

4. Tension bars shall be steel strip, 5/8 inch wide by 3/16 inch thick.

5. Tension bands shall be pressed steel, 14 gage thickness by 2 inch wide.

6. Brace bands shall be pressed steel, 12 gage thickness by 2 inch wide.

7. Truss rods shall be steel rod, 3/8 inch diameter merchant quality with turnbuckle.

8. Channel mounting bolts shall be hot dip galvanized meeting ASTM F 1554, Grade 36, with nuts meeting ASTM A563 and flat washers.

G. Tension Wire

1. Tension wire shall be marcelled 7 gage steel wire with minimum coating of 0.80 ounces of zinc or 0.40 ounces of aluminum per square foot of wire surface and conforming to ASTM A 824.

H. Tie Wires

1. Tie wires shall be aluminum 9 gage, alloy 1100-H4, A58 self locking fabric bands or equal.

I. Hog Rings

1. Hog rings shall be steel wire, 11 gage with a minimum zinc coating of 0.80 ounces per square foot of wire surface.

PART 3 EXECUTION

3.1 INSTALLATION

A. Fence installation shall conform to requirements of ASTM F 567.

B. Provide fence heights as shown on Contract Drawings.

C. Space line posts at intervals not exceeding ten feet.

D. Set terminal, gate and line posts plumb in concrete footings as shown on Contract Drawings. Top of footing shall be 2 inches above grade and sloped to direct water away from posts.

E. Brace gate and terminal posts back to adjacent line posts with horizontal brace rails and diagonal truss rods.

F. Install top rail through line post loop caps connecting sections with sleeves to form a continuous rail between terminal posts. Fasten top rail to terminal posts.

G. Stretch bottom tension wire between terminal posts 6" above grade and fasten to outside of line posts with tie wires.

H. Pull fabric taut to provide a smooth uniform appearance, free from sag, with bottom selvage 2" above grade. Fasten to terminal posts with tension bars threaded through mesh and secured with tension bands at maximum 18" intervals. Tie to line posts and top rails with tie wires spaced at maximum 14" on posts and 24" on rails. Attach to bottom tension wire with hog rings at maximum 24" intervals.

I. Install gates plumb, level and secure for full opening without interference. Anchor center stops and keepers in concrete. Adjust and lubricate hardware for smooth operation.

J. Install nuts for fittings, bands and hardware bolts on inside of fence. Peen ends of bolts or score threads to prevent removal.

END OF SECTION 32 31 13

SECTION 329119.13 - TOPSOIL PLACEMENT AND GRADING (TOPSOIL)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnishing and placing topsoil in conformance with the lines, grades and thicknesses shown on the plans or as required for acceptance by the Engineer.
B. Furnishing and placing topsoil in conformance with the minimum requirements as noted under other Contract Work Items (i.e. Seeding, Topsoil and Sodding, etc.).

1.2 RELATED WORK

A. Finish Grading - Section 312219
B. Seeding - Section 329219

1.3 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 GENERAL

A. Ordinary topsoil shall be the surface layer of soil and sod, suitable for use in seeding and planting.
B. Ordinary topsoil or Topsoil from Borrow shall be friable, loamy and contain no mixture of refuse or any substance toxic to plant growth, and shall be free from sub-soil, debris, stumps, brush, roots, clay lumps, stones, or similar objects larger than 3/8 inches (0.375") in greatest dimension.
C. The topsoil or soil mixture, unless otherwise specified, shall have an acidity range of approximately 6.0 pH to 7.6 pH, when tested according to the methods of A.O.A.C., in effect on the date of the invitation to bids.
D. The organic content shall be not less than 6% nor more than 12% as determined by the wet combustion method (chromic acid reduction).
E. There shall be not less than 10% nor more than 30% passing the 200-mesh sieve as determined by the wash test made in accordance with the standard test ASTM Designation D1140.
F. Natural topsoil may be amended by the Contractor with acceptable materials and methods, to meet the above specifications.

2.2 QUALITY ASSURANCE

A. Samples of the topsoil or soil mixture will be taken by the Owner or his designated representative.
B. All topsoil from borrow will be tested unless otherwise accepted.
C. Testing may be done by the U.S. Department of Agriculture, Soil Conservation Service, the New York State Department of Transportation, Bureau of Soil Mechanics, or any independent testing laboratory acceptable to the Owner and Engineer.
D. The Contractor shall notify the Engineer of the intended source of material at least three (3) weeks in advance of the scheduled use of the material, to allow time for sampling, shipping of the sample and testing.

E. If at any time the quality of the topsoil being utilized becomes questionable, the Contractor shall perform such additional testing as necessary to demonstrate the acceptability of the material being used.
F. The Contractor shall furnish, at his own expense, suitable excavating equipment as required for taking of samples by the Owner or his representative.
G. All costs for sampling and testing shall be borne by the Contractor and shall be deemed included in the unit price bid for topsoil or the associated Items.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL
A. Placement of topsoil shall be in strict accordance with the details shown and the specific requirement of the related specifications.
B. No material shall be utilized unless it meets all the "Material" and test requirements.

3.2 SUB-SOIL PREPARATION
A. The sub-soil within the areas to be covered by topsoil shall be graded so that the completed work shall conform to the specified lines and grades.
B. Unless otherwise noted or accepted, the Contractor shall scarify or till the surface of the sub-soil before the topsoil is placed to permit bonding of the topsoil with the sub-soil.
C. Tillage by disking, harrowing, raking, or by other methods acceptable to the Engineer shall be accomplished in such a manner that depressions and ridges formed by the tillage shall be parallel to the contours.
D. Brush and vegetation which will not be incorporated with the soil during handling operations shall be cut and removed prior to stripping.

3.3 TOPSOIL PLACEMENT
A. Topsoil in an unworkable condition due to excessive moisture shall not be placed until it is suitable for spreading.
B. Topsoil shall be placed on the designated areas and spread to the specified thickness.
C. After the topsoil is spread, all large soil clogs, rocks, roots and other foreign material shall be cleared and disposed of by the Contractor so that the finished surface will be acceptable for subsequent work, such as seeding, sodding, mulching or planting.
D. Ordinary sods and herbaceous growth, such as grass and weeds, are not to be removed but shall be thoroughly broken up and intermixed with the soil during handling operations.

3.4 EROSION CONTROL
A. It is the responsibility of the contractor to ensure that the soil of the topsoil preparation area is not blown or washed from the site and that nearby areas are protected from soil, fertilizer, compost, etc.
B. In the event of heavy rain or win that cause damage to the site, then the contractor will repair the damaged areas so they are restored to a condition acceptable under the specifications.
C. Watering of seeded areas will be done with equipment necessary to prevent seed from being displaced from its original location.

3.5 ACCEPTANCE OF WORK

A. A uniform grade will be established so that no depressions or elevations are present, and so that the safe and effective operation of mowing equipment will not be hindered after the turf grass is established.
B. The topsoil will not be loose whereby footprints greater than 0.5 inch are observed, nor will it be too dense whereby only footprints less than one-quarter of an inch are observed.

3.6 WATERING
A. The Contractor must use the application of water to insure the development of the turf.
B. Daily watering will be required throughout the growing period unless otherwise directed by the Engineer. The application of water on a daily basis must be a high priority for the Contractor.
C. Upon notice from the Engineer, the Contractor will water the established turf areas as soon as feasible but not more than 24 hours after notification.

3.7 MAINTENANCE
A. General:
1. All seeded areas will be maintained during the growing periods until project final completion.
2. Maintenance includes watering, weeding, fertilizing and mowing to establish turf and create an adequate root system on the seeded areas.
B. Weeding and Mowing:
1. The Contractor will be required to perform weeding and mowing of the newly established turf to ensure that an acceptable product is achieved at final completion.
2. Prior to the initial mowing, the Contractor will be responsible removing any weeds from the seeded areas.
3. The Contractor will perform an initial mowing of the turf when the grasses reach a height of 6 inches or as directed by the Engineer, and will be cut to a height of 3 inches during the initial and each subsequent mowing.
4. After the initial mowing, the Contractor will require to perform additional mowing anytime that the developing grasses exceed a height of 4 inches or as directed by the Engineer.
5. For the purposes of planning for mowing operations, the Contractor should assume that the entire project site will need to be mowed 3 weeks after initial application of seed and every 1 week thereafter for the duration of the growing period.
6. All mowing must be completed using a lightweight push mower or approved alternative as determined by the Engineer.
7. No erosion washes, clumps or deformation of the turf area caused by mowing or other Contractor equipment will be allowed.
8. Remove and dispose weeds off site.

C. ACCEPTANCE OF WORK
1. Prior to final completion, the Engineer will make the final inspection and consideration acceptance of the seeding.
2. No relief will be granted to the Contractor for the failure of turf to establish for any reason, including the PennDOT summer and fall blackout dates.

3. Satisfactory seeded turf will be healthy in color, uniform, free of weeds and surface irregularities, with coverage exceeding 95% and bare spots not exceeding 4 inches x 4 inches. No erosion washes, clumps or deformation of the turf area caused by mowing or other Contractor equipment will be allowed.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAYMENT

A. Where topsoil work is called for as part of individual Contract Items, the cost for all work related to the topsoiling, as required by this specification, shall be included in the individual prices bid for the respective Contract Item.

B. If the Contract Proposal includes a separate "Topsoiling" Item, the cost for all work related to all topsoiling, not included under any other items, shall be paid for under the price bid under the "Topsoiling" Item. If no such item for payment is provided within the Proposal, all topsoiling costs shall be deemed included in the other prices bid in the Proposal, and no separate payment for this work shall be made.

END OF SECTION 329119.13

SECTION 329219 - SEEDING

PART 1 - GENERAL

1.1 WORK INCLUDED:
- A. Preparing all ground surfaces as required.
- B. Furnishing and sowing seed on areas shown on the plans, all other disturbed areas, and areas of restoration and caring for the work as specified.
- C. Action and means as necessary for control of soil erosion and stability maintenance.

1.2 RELATED WORK:
- A. Finish Grading - Section 312219

1.3 EXISTING CONDITIONS:
- A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 GENERAL:
- A. Each of the species, variety and strain of grasses, legumes and cereals shall be as specified, unless otherwise acceptable to the Engineer.
- B. All seed and seed labels shall be in accordance with State and Federal Laws, Rules and Regulations as each is in effect on the date of Invitation for Bids.

2.2 SEED LOT CONTENT:
- A. The weight of pure live seed in each lot of seed is computed by the labeled purity percent, times the labeled germination percent, times the weight. (Example: 34 pounds of pure live seed of a particular grass is required. Stock available has 85% purity and 80% germination which meets the minimum requirements in this example and equals 68% pure live seed; 34 divided by 68% equals 50 pounds gross as being required to furnish the 34 pounds of pure live seed.) Other material shall comprise the remaining 32% between 68% of pure live seed and 100% in the example.
- B. The Contractor shall furnish the vendor with the specifications for the material. Seed mixes shall be as follows or approved equal:

New Fields	TURFGRASS SPECIES	% BY WT.	SEED RATE (lbs./Sq. ft)
	Kentucky Blue Grass	80%	3-4
	Perennial Ryegrass	20%	3-4

- C. Material other than the pure live seed shall comprise only non-viable seed, chaff hulls, live seed of crop plants other than those specified, harmless inert matter and weed seeds, except that weed seeds, other than seeds of noxious weeds will be permitted up to 1% of the gross weight of each kind of seed. Legume seeds shall be accompanied by adequate amounts of their proper inoculants unless accompanied by certification of pre-inoculation.

2.3 INOCULATION:

A. All the seed of leguminous plants shall be inoculated prior to mixing or sowing unless otherwise specified or approved or unless accompanied by a certificate of pre-inoculation. It is very important to use crownwatch inoculant at double the usual rate; follow carefully the instructions on the inoculant bag. When seed is to be sown dry and is to be inoculated, the culture shall be applied as directed by the manufacturer and seed allowed to dry sufficiently to be in the proper condition for mixing or sowing. Seed must be sown within thirty (30) hours after this treatment. When seed is to be distributed by water pressure, proper proportion of inoculant may be added to water and seed mixture, together with any limestone or fertilizer specified, providing the alkalinity of the solution does not exceed a pH of 8.

B. The inoculants for treating seeds of legumes shall be standard culture of nitrogen fixing bacteria not more than one (1) year old. Each inoculant shall be the specific culture required by each legume. It shall be supplied only from the manufacturers licensed to sell legume inoculants in New York State.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL:

A. Each kind of seed shall be furnished and delivered, unless otherwise approved, in separate, sealed containers, or bags acceptably sewn tight or sealed.

B. The percentage of purity as shown on the label will be acceptable if in conformance with these specifications. Percentage of germination as shown on the label shall not be less than the minimum percentage specified. The common and scientific names of the grasses, legumes and cereals under this contract are in conformity with the Standardized Plant Names adopted by the American Joint Committee on Horticulture Nomenclature and in effect on the date of the Invitation for Bids.

C. The seeds shall meet the minimum specified requirements regardless of the guarantee of the qualities or dates of testing.

3.2 TIME FOR WORK:

A. This work may be performed at any season of the year when a mulch is used unless otherwise specified.

B. When conditions of high winds, excessive moisture, or ice are such, that satisfactory results are not likely to be obtained, the work shall be stopped, and will be resumed only when the desired results are likely to be obtained or when acceptable corrective measures and procedures are adopted.

C. The Contractor shall notify the Engineer at least forty-eight (48) hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been obtained.

3.3 ACCEPTANCE:

A. Provisional acceptance of the seeds must be obtained before the seeds are mixed. Each lot of seed shall be subject to sampling and testing before mixing. Sowing seed shall not be delayed pending reports of these tests. Sampling

shall be accomplished by the Owner's Representative. Seeds of the kind specified shall be mixed on the job in the formula specified unless otherwise accepted. Seed mixed prior to delivery may be accepted on the basis of certification by the vendor stating the minimum percentage of germination and purity of each kind of seed and the quantity of each kind of seed in the mixture.

B. The provisional acceptance of seeds must be obtained before the seed is sown. Final acceptance may be subject to the results of official sampling and testing.

3.4 STORAGE:

A. Seed after delivery to the Contractor shall be stored in such a manner as to protect it from damage or deterioration from any source.

B. Seed, which has become wet, moldy, or otherwise damaged in transit or storage will not be acceptable and shall be removed from the site immediately upon such damage being discovered.

3.5 MAINTENANCE:

A. Areas to be seeded shall be maintained at acceptable grades. Irregularities, which will form low places and hold water shall be eliminated. Limestone, fertilizers, and seeds in amounts specified shall be evenly distributed on the surfaces to be seeded. Rates, unless otherwise specified, are as follows:

1. Fertilizer - 800 pounds/acre (20 pounds/1,000 sq. ft.)
2. Seed - 150 pounds of pure live seed/acre (3 to 4 pounds / 1,000 sq. ft.)

B. Agriculture limestone, fertilizer and seed may be mixed together immediately before placing. Any method of distribution, such as by air or water pressure, will be acceptable except that the seed shall not be injured in the process of spreading.

C. The Contractor shall care for the seeded and mulched areas until final acceptance of the project. Such care shall consist of repairing any areas damaged following the seeding or mulching operations due to wind, water, fire or other causes. Such damaged areas shall be repaired to re-establish the condition and grade of the area prior to seeding, and shall then be refertilized, re-seeded and re-mulched as specified herein.

END OF SECTION – 329219

SECTION 329300 - TREES, SHRUBS AND GROUND COVERS

PART 1 - GENERAL

1.1 Applicable provisions of the Conditions of the Contract and Division #1, General Requirements, govern work in this Section.

1.2 DESCRIPTION OF WORK

A. The work of this Section consists of the provision of all plants, materials, labor and equipment and the like necessary and/or required for the complete execution of all landscaping including tree, shrub and ground cover planting for this project as required by the schedules, keynotes and drawings, including, but not limited to the following:

1. Spread topsoil planting medium from site stockpiles and, if required, furnish any and all additional materials to establish the plant beds in accordance with the specifications and drawings. Topsoil shall be placed over subgrades to establish finished grade in areas designated within the Contract Limit Lines and to the extent required to restore adjacent disturbed areas.
2. Perform all treatment or amendment of topsoil (loam) as recommended by a laboratory soil analysis.
3. Prepare tree pits and planting beds including preparation of planting soil mix.
4. Provide all nursery stock and plant such trees, shrubs, ground covers, vines, bulbs, perennials and all other miscellaneous planting as indicated; staking and guying (if indicated/detailed); pruning; spraying and weeding; mulching; and fertilizing, watering and maintenance of all plant materials.
5. Perform horticultural services and provide plant replacement guarantees.

1.3 RELATED SECTIONS - Entire Project Specification with specific reference to those sections noted herein and as follows:

A. 015713 Temporary Erosion Controls
B. 311000 – Site Clearing
C. 312000 Earth Moving

1.4 QUALITY ASSURANCE

A. Materials and labor required for execution of work herein shall generally be governed by the standards as specified in Part 2.
B. Work required herein shall be performed by a firm specializing in said work and shall be under the full-time supervision of an experienced nurseryman or horticulturist. If required by jurisdiction, Contractor shall be licensed/certified to execute the work herein.
C. Ship all materials with certificates of inspection as required by governing authorities. Comply with regulations applicable to materials to be used to complete the work of this Section.
D. Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in accordance with

methods established by the Association of Official Agriculture Chemists, wherever applicable.

E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above the ground for trees up to and including 4-inch caliper size, and 12 inches above the ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

F. Observation: Architect may observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

G. 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.

1. Provide representative samples of topsoil and organic or inorganic amendment materials proposed for use in the project to an independent testing agency 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.

   a. All soil samples and proposed amendments shall be sent to:
      Hummel & Company, Inc. / Turf & Soil Diagnostics - NY
      35 King Street
      Trumansburg, New York 14886
      (607) 387-5694 or (855) 769-4231

2. All reports shall be sent to the Architect for approval.
3. Samples of imported topsoil to be brought to the site must be approved prior to delivery.
4. Deficiencies in the topsoil shall be corrected by the Contractor, as directed by the Architect, and based on the testing lab report.
5. Ensure test reports include specific recommendations regarding exact types, times and rates of application of soil amendments and fertilizers based upon soil test results and type of planting proposed as necessary to establish the required pH factor, organic matter content and supply of nutrients satisfactory for planting. Follow soil additive recommendations before and during topsoil respread operations. Include the following in the topsoil analysis:
   a. pH factor
   b. Percent organic matter as determined by a Loss on Ignition or Walkey/Black Test (ASTM F-1647).
   c. Proctor testing per ASTM D698.

d. Chemical analysis testing nitrogen, phosphorus, potassium, calcium, magnesium, cation exchange capacity, base saturation percentages, micronutrients and acidity (pH).
e. Particle size analysis of the topsoil as determined by ASTM F-1632, performed and compared to the USDA Soil Classification System.
f. 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.

H. Qualification of Arborist: All work of pruning shall be performed by an arborist certified by the New York State Arborist Association or the International Society of Arboriculture.

I. Reference Standards
1. Comply with the provisions of the Manual of Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration, United States Department of Labor.
2. ASNS: "American Standard for Nursery Stock," ANSI Z-60.1, latest edition, published by the American Association of Nurserymen, (AAN).
3. A.S.A.: American Society of Agronomy: Soil Science Society of America, Methods of Soil Analysis, 2nd edition.
4. AOAC: Association of Official Agricultural Chemists
5. Hillier's Manual of Trees and Shrubs, 1971, Hillier & Sons.
6. Manual of Cultivated Conifers, 1965, P. Den Ouden & B.K. Boom.
7. Hortus III, 1976, L.H. Bailey Hortorium.
8. Pruning Standards: The "Standards for Pruning Shade Trees" of the National Arborist Association, 174 Route 101, Bedford, NH 03102.

J. Definitions
1. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.
2. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.
3. Finish Grade: Elevation of finished surface of planting soil.
4. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
5. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.5 SUBMITTALS – Coordinate with Section 013300

A. Submittals shall be made in groupings where installations are complementary. Failure to comply with this requirement will be cause for rejection of any or all submittals.

1. As set forth in Sections 013300 and 013200, prepare and submit a fully developed submittal schedule; note review times set forth in Section 013300 are deemed “average”, for large submissions allow longer review times.
2. Attention is directed to Section 013114 for coordination drawing requirements for this project. These drawings are critical to the proper execution of the Work and failure to honor these requirements may become the basis for denial of any and all claims for either or both “time” and “money”.
3. The Contractor is encouraged to submit for approval products made from recycled and/or environmentally responsible material. The substitution request procedure shall still be enforced.

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

C. Samples for Verification: For each of the following:
   1. Planting bed mulch.

D. Qualification Data: For landscape Installer.

E. Material Test Reports: For existing surface soil and imported topsoil.

F. Planting Schedule: Indicating anticipated planting dates for exterior plants.

G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

H. Material Safety Data Sheet (MSDS) must be submitted for each product.

1.6 MAINTENANCE

A. A program of Owner Maintenance of planting shall be developed and submitted as per "Operation and Maintenance Requirements" specified in Section 017823.

B. Responsibility for maintenance shall be coordinated between the Contractor and Owner to ensure an appropriate level of care for all new plantings through the time of final acceptance of the work.

C. The Owner will be responsible for the maintenance of the new planting beginning at the date of acceptance and continuing through the guarantee period.

D. Planting Maintenance
   1. Maintenance shall begin immediately after each plant is planted and shall continue until the final acceptance of the planting.
   2. Maintenance shall consist of keeping the plants in a healthy growing condition and shall include watering, weeding, cultivating, remulching, tightening and repairing of guys, removal of dead material, resetting plants to proper grades or upright position and maintaining the planting saucer.
   3. Plants shall be inspected for watering needs at least twice each week and watered to promote plant growth and vitality. The following watering rates assume that the soil is free draining. If the on-site conditions do not provide a free draining soil, notify the Architect in writing of this condition.

   4. For trees in lawn or mulched beds, apply water to the ground surface directly under the canopy. Water shall be applied at a sufficiently slow rate to prevent runoff from the soil surface but great enough to equal 1 inch of water per square foot of canopy per week.

   5. Stakes shall be kept plumb and neat in appearance. Guys, wires and anchoring cables shall be inspected and repaired weekly.

6. Planting beds and individual plant pits shall be kept free of weeds, and mulch shall be replaced as required to maintain the specified layer of mulch. Beds and individual pits shall be neat in appearance and maintained to the designed layout.

7. Plants that die during the maintenance period shall be removed and replaced by the Contractor within one week of notification and replaced during that growing season, unless designated otherwise by the Architect.

8. Work of pruning, fertilizing, spraying, and similar activities shall be undertaken only by Certified Arborists and licensed chemical applicators, as pertinent to the work being performed.

E. Seasonal spraying as required shall also be included. Pesticides shall be approved by the Architect prior to use and shall be used in accordance with the specifications of the manufacturer.

F. Planting areas and plants shall be protected at all times against trespassing and damage of all kinds for the duration of the maintenance period. If any plants become damaged or injured, they shall be treated or replaced as directed by the Architect at no additional cost to the Owner.

G. Defective work shall be corrected as soon as possible after it becomes apparent and weather and season permit.

H. During the maintenance period, a decline in the condition of plantings shall require the Contractor to take immediate action to identify potential problems and undertake corrective measures. If required, the Contractor shall engage professional arborists and/or horticulturalists to inspect plant materials and to identify problems and recommend corrective procedures.

I. Full and complete written instructions for proper care and maintenance of plantings shall be furnished by the Contractor to the Owner at least 30 days prior to the end of the maintenance period. Provide a copy of the instructions to the Architect for approval.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING (Coordinate with Section 016100)

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer.

B. Protect all materials from deterioration during delivery and while stored at the site.

C. Provide freshly dug plantings. Do not prune prior to delivery. Do not bend or bind-tie trees or shrubs in such a manner so as to damage bark, break branches or destroy natural shape. Provide protective coverings during delivery.

D. Deliver plantings after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set plantings in place, protect from weather and mechanical damage and keep roots moist. Do not remove container grown stock from containers until planting time.

E. Perform labeling operations with at least 1 tree and 1 shrub of each variety by securely attaching a waterproof tag with a legible designation of both common and botanical name.

1.8 CERTIFICATE OF ACCEPTANCE

A. After the minimum 30-day maintenance period, the Contractor shall request the Architect, in writing, for an inspection to determine whether the plant material is acceptable. If the plant material and workmanship are acceptable, written notice will be given by the Architect to the Contractor stating that the guarantee period begins from the date of the Certificate of Acceptance.

B. Depending upon the progress of the work, the Architect may, at his option, issue partial certificates of acceptance for areas of work as determined by him. The contractor's duty of maintenance for such areas shall cease upon receipt of such certification except such duties shall continue with regard to all other areas or portions of work until such certification covering those portions is received.

C. If any plants are sickly or dead at the time of inspection, acceptance will not be granted, and the Contractor's responsibility for maintenance of all plants shall be extended until replacements are made. All dead and unsatisfactory plants shall be promptly removed from the project. Replacements shall conform in all respects to the specifications for new plants and shall be planted in accordance with these specifications.

1.9 SPECIAL GUARANTEE/WARRANTY TERMS

A. All work of this section shall be guaranteed for a period of 1 year, OR not less than 2 full planting seasons from the date of Final Acceptance in accordance with the Conditions.

1. Plants shall be guaranteed for a period as set forth above, after inspection and acceptance and shall be alive and in satisfactory growth at the end of the guarantee period. The sum of 10% of the total cost of the planting contract shall be retained and paid to the Contractor after replacements have been made and one year from acceptance of original planting.
2. At the end of the guarantee period, inspection will be made again. Any plant required under this contract that is dead or unsatisfactory shall be removed from the site. Each plant shall show at least 75% healthy growth and shall have the natural characteristics of a plant of its species in accordance with the American Nurseryman's Association standards. Plant replacements shall occur during the normal planting season and shall be subject to the guarantee/warranty terms until the plants live through one year. A final inspection for acceptance will be made after the replacement plantings have lived through one year.
3. All replacements shall be plants of the same kind and size specified in the Plant List. The cost will be borne by the Contractor, except for replacements due to vandalism, neglect or damage on the part of others.

1.10 SUSTAINABILITY

A. In the selection of the products and materials of this section as well as for the entire project, preference will be given to those with the following characteristics:

1. Water based
2. Water-soluble
3. Can be cleaned up with water
4. Non-flammable
5. Biodegradable
6. Low or preferably no Volatile Organic Compound (VOC) content

7. Manufactured without compounds that contribute to ozone depletion in the upper atmosphere
8. Manufactured without compounds that contribute to smog
9. Do not contain methylene-chloride
10. Do not contain chlorinated hydrocarbons
11. Contains the least possible of post-consumer or post-industrial waste

PART 2 - PRODUCTS

2.1 GENERAL - All materials shall be governed by the applicable portions of the REFERENCE STANDARDS set forth in Part 1 above or as may be modified herein.

2.2 TOPSOIL - as per Section 329200 as if restated herein in full.

2.3 SOIL ADDITIVES

A. Commercial fertilizer, peat, humus or other additives shall be used to counteract soil deficiencies as recommended by the soil analysis and as directed by the Architect.

B. Commercial fertilizer shall be a product complying with State and United States Fertilizer Laws. Deliver to the site in the original unopened containers which shall bear the manufacturer's Certificate of Compliance covering analysis which shall be furnished to the Architect. At least 50% by weight of the nitrogen content shall be derived from organic materials. Fertilizer shall contain not less than the percentages of weight of ingredients as follows, but shall be adjusted to meet all recommendations of the soil analysis.

	Nitrogen	Phosphorus	Potash
For deciduous shrubs	10%	6%	4%
For evergreen shrubs	7%	7%	7%

C. Limestone: Ground limestone shall be an approved agricultural limestone containing not less than 85% of total calcium or magnesium carbonates. Limestone shall be ground to such fineness that 40% will pass through a 100-mesh sieve and 95% will pass through a 20-mesh sieve.

D. Humus shall be natural humus, reed or sludge peat free from excessive amounts of zinc, low in wood content, free from hard lumps and in a shredded or granular form. According to the methods of testing of A.O.A.C., latest edition, the acidity range shall be approximately 5.5 pH to 7.6 pH and the organic matter shall be not less than 85% as determined by loss on ignition. The minimum water absorbing ability shall be 200% by weight on an oven-dry basis.

E. Peat Moss shall be composed of the partly decomposed stems and leaves of any or several species of sphagnum moss. It shall be free from wood, decomposed colloidal residue and other foreign matter. It shall have an acidity range of 3.5 pH to 5.5 pH as determined in accordance with the methods of testing of A.O.A.C., latest edition. Its water absorbing ability shall be a minimum of 1,100% by weight on an oven-dry basis.

F. Manure shall be well-rotted, unleached stable manure not less than 8 months old and not more than 2 years old. It shall be free from sawdust, shavings or refuse of any kind and shall not contain over 25% of straw. Furnish information to the Architect as to the kind of disinfectant or chemicals, if any, that may have been

used in storage of, or otherwise in connection with, the manure. No manure may be used until found satisfactory after sampling and testing. A composition of peat humus or peat moss to which has been incorporated dehydrated manure, such as Bovung or Spurson in the proportion of 100 pounds of dehydrated manure per cu.yd. of peat, may be substituted for manure as specified above.

G. Superphosphate shall be composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than 18% available phosphoric acid.

H. Bone meal shall be fine ground, steam cooked, packing house bone with a minimum analysis of 23% phosphoric acid and 4% nitrogen.

I. Leaf mold shall be a highly organic dark brown to black spongy residue resulting from the well aerated composting of deciduous tree leaves. It shall be at least three years old, without recognizable leaf parts, free of plants and their roots, debris and other extraneous matter and shall be uncontaminated by foreign matter and other substances harmful to plant growth. The organic matter shall be not less than 85% by weight as determined by loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 110 degrees C. The inorganic residue after ignition shall not be finer textured than 4% by weight passing the Number 200 sieve with washing.

K. Sand shall consist of hard, durable grains of quartz or other rock, clean and free from foreign matter or chemical contamination.

2.4 PLANTING SOIL MIX

A. Planting soil mix shall be approved loam (topsoil) which meets, or has been adjusted to meet, the particular planting applications as directed below. Planting mix shall conform to the following pH levels:

1. For plants requiring an acid soil, planting mix shall have a true pH of 4.5 to 5.5. If it has not, it shall be amended by the Contractor at his own expense to the proper pH range by mixing with sulphur as specified herein.
2. Planting mix for general planting of non-acid-loving plants shall have a true pH value of 6.0 to 6.5. If it has not, it shall be amended by the Contractor at his own expense to the proper pH range by mixing with dolomitic limestone as specified herein.
3. The amount of either sulphur or limestone required to adjust the planting mix to the proper pH range (above) on the basis of soil tests as specified herein.

B. Planting soil mix shall consist of pH adjusted loam which has been thoroughly premixed with organic material in the proportions of 1 part peat moss with 5 parts of approved loam.

2.5 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be

used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

D. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.6 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
   1. Provide balled and burlapped trees.

B. Small Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
   1. Stem Form: Single stem or Multistem, clump, with two or more main stems.
   2. Provide balled and burlapped trees.

2.7 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.
   1. Provide balled and burlapped or container grown shrubs.

2.8 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
   1. Provide balled and burlapped or container grown shrubs.

2.9 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover plants of species indicated, established and well rooted in containers or flats, and complying with ANSI Z60.1.

2.10 NON-WOODY PLANTS

A. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

2.11 FERTILIZER

A. Fertilizer shall be provided for each plant using slow-release fertilizer packets which are designed and certified by the manufacturer to provide controlled release of fertilizer over a multi-year period. Each packet shall consist of four ounces of water-soluble fertilizer with a minimum guaranteed analysis of available elements as follows:

Nitrogen	16%
Phosphoric Acid	8%
Potash	8%

Fertilizer packets may be obtained from ADCO Works, P.O. Box 310, Hollis, NY 11423, Telephone 1-718-739-0701, or from Unique Fertilizers Inc., P.O. Box 99, Deptford, NJ 08096, Telephone 1-609-848-4444.

2.12 MULCH

A. Bark mulch shall be pine bark mulch aged a minimum of 6 months and not longer than 2 years. The mulch shall be natural dark brown in color (not dyed), free of dirt, extraneous materials and pieces of wood thicker than 1/2 inch. Mulch must be free of stringy material or chunks over 2 inches in size and shall not contain, in the judgment of the Architect, an excess of fine particles. Submit sample for the Architect's approval.

2.13 WATER

A. Water new plant beds at a rate of 1 inch (25 mm) per week or as needed to maintain moist soil for the duration of the maintenance period.

2.14 ANTIDESICCANTS

A. Antidesiccants shall be emulsions or other materials which will provide a protective film over plant surfaces permeable enough to permit transpiration and specifically manufactured for that purpose. Antidesiccant shall be subject to the Architect's approval and shall be used only after approval by the Architect. Antidesiccant shall be delivered in containers of the manufacturer and shall be mixed and applied according to the manufacturer's instructions.

2.15 STAKING, GUYING AND ANCHORING MATERIALS

A. Stakes for supporting trees shall be of sound hardwood of uniform shape and size, reasonably free of knots, insects and fungi and capable of standing in the ground at least 2 years. Unless noted otherwise, stakes shall be 4 feet long, of 2 inches by 2 inches nominal size and pointed at one end.

B. Hose to encase guy wires shall be new two-ply reinforced rubber garden hose not less than 1/2 inch inside diameter. Color shall be black.

C. Cable and Fittings:

1. Cable shall be 3/16-inch diameter, 7 strand (7 by 19), galvanized steel cable.
2. Turnbuckles and eye bolts shall be of galvanized steel of size and gauge to provide tensile strength equal to that of the cable. Turnbuckle opening shall be a minimum of 3 inches.
3. Cable clamps shall be malleable compression sleeves of zinc plated copper. Sleeves shall be of double-barreled configuration for looped connection and sized to match the steel guy or anchor cable.

PART 3 - EXECUTION

3.1 INSPECTION AND ACCEPTANCE

A. Examine all surfaces and contiguous elements to receive work of this section and correct, as part of the Work of this Contract, any defects affecting installation. Commencement of work will be construed as complete acceptability of surfaces and contiguous elements.

3.2 PREPARATION AND RESTRICTIONS

A. Furnishing and planting of plant material includes the digging of the holes, provision of soil additives and loam, furnishing the plants of specified size with roots in the specified manner, the labor of planting, fertilizing, mulching, guying and staking where called for, and maintenance.

B. The Contractor shall locate plant material sources and ensure that plants are shipped in timely fashion for installation.

C. Seasons for Planting:

1. Spring Planting: Deciduous, 21 March through 1 May
   Evergreen, 15 April through 15 June
2. Fall Planting: Deciduous, 15 September through 1 December
   Evergreen, 15 August through 15 October

D. Proceed with and complete all work herein as rapidly as approved portions of site become available.

E. Plant Material Selection at the Nursery:

1. This subsection shall apply only when the drawings specifically state that plant selection by the Architect is required at the nursery.
2. At least one month prior to the expected planting date, the Contractor shall request that the Architect provide a representative to select and tag nursery stock to be planted under this Section. The Owner shall pay for the transportation, subsistence and accommodations as may be necessary for the Architect's representative to visit the nursery and select and tag the plant material.
3. The Contractor shall be responsible to confirm the availability of required plantings in specified sizes from his source of supply prior to requesting the Architect to make plant source inspections. In the event that plants are found to be unacceptable or unavailable at the time of the Architect’s visit, the Contractor shall be liable to reimburse the Owner for all costs of the Architect's services incurred during unproductive inspection trip(s).
4. A representative of the Contractor shall accompany the Architect on all plant selection trips.
5. All plants, or representative plants, for the project shall be individually tagged with the Architect's seals, and no plants shall be accepted for delivery to the project site without such seals. Representative samples may be tagged as "Approved Typical Sample" and shipped to the site with the remaining untagged quantities of plants specified, for approval. Any such plant which arrives at the construction site which does not match the Approved Typical Sample may be rejected by the Architect.
6. Inspection and tagging of plantings at the source shall not impair the right of subsequent inspection and rejection upon delivery to the site, or during the progress of the work; if the Architect finds that plants have declined noticeably due to handling abuse, lack of maintenance, or other causes. Cost of replacements, as required, shall be borne by the Contractor.

3.3 PLANTING

A. Notify the Architect 3 working days prior to the proposed arrival of plant material on the site. All plant material shall be planted within 5 days of arrival on site or will be rejected by the Architect. Shrubs stored on site shall be shaded from direct sunlight at all times. Plants shall not be stored on paved surfaces. All

plants delivered to the site and not planted within 24 hours of delivery shall have their root balls covered with mulch and shall be watered on a daily basis.

B. Locations for all trees and outlines for planting areas shall be staked on the ground by the Contractor for approval by the Architect before plant pits or plant beds are dug.

C. Plant Pits:
   1. All plant pits dug with a machine shall have the sides of the holes scraped with hand shovels to prevent glazing and compaction of the side of the hole. Remove and stockpile excavated topsoil and subsoil in separate stockpiles. All subsoil excavated from the bottoms of planting pits and unused at the end of the planting operations shall be removed from the site.
   2. No trees shall be planted in tree pits with saturated soil or standing water.
   3. Plant pits shall be dug to the dimensions shown on the Drawings, but in no case shall be less than the following:
      a. Holes for trees shall be at least 2 feet greater in diameter than the ball. Where pavements restrict the size of planting pits, the hole shall be the maximum diameter along the edges abutting pavement.
      b. Pits for individual shrub planting shall be at least 1 foot greater in diameter than the ball.

D. Prepared planting soil mix shall be backfilled at individual tree and shrub planting pits.

E. Shrub planting beds shall be excavated and backfilled with planting soil mix to a minimum uniform depth of 24 inches below final grade, or as shown on the Drawings.

F. All plant roots and earth balls must be damp and thoroughly protected from sun and wind from the beginning of the digging operation, during transportation and on the ground until the final planting. The plants shall be planted in the center of the holes and at the same depth as they previously grew. After completion of planting installations, remove rope, and wires from the upper half of the root balls. Do not pull burlap or wires out from sides or under root balls. Topsoil and/or planting soil mix shall be backfilled in layers of not more than 6 inches and each layer watered sufficiently to settle before the next layer is put in place. A saucer shall be formed around each plant at a depth of 4 inches for trees and 2 inches for shrubs. All topsoil excavated from the planting pit shall be used to backfill the pit; supplement with planting soil mix as necessary.

G. At the time of planting, install fertilizer packets at a depth of 6 to 8 inches equally spaced around the plant as it is being backfilled. Packets shall be placed approximately 3 inches away from the plant roots or plant ball. Packets shall not be cut, ripped or damaged. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets. The application rates for fertilizer packets shall be as follows:

Type of Plant	Rate
Deciduous Shade Trees	One packet for each inch of caliper
Evergreen and Small Flowering Trees	One packet for each 18 inches of height
Shrubs	One packet for each 12 inches of height or spread

H. All plants shall be watered immediately following planting as necessary to thoroughly moisten rootball and plant pit loam and thereafter shall be inspected frequently for watering needs and watered, as required, to provide adequate moisture in the planting pit.

I. If shown on drawing details, all trees shall be firmly guyed or anchored at the time of planting. Cables used for tying the trunk to stakes for guying shall be secured to the tree by passing through an approved hose to prevent chafing and injury to the trees. Cable ends shall be formed with a looped connection which is secured with compressed malleable fittings as specified.

J. Mulch material shall be placed over entire saucer areas of individual trees and shrubs and over the entire area of planting beds to a depth of 3 inches after settlement, not later than 2 days after planting.

K. If planting is done after lawn preparation or installation, proper protection of lawn areas shall be provided and damage of lawn resulting from planting operations shall be repaired immediately at no cost to the Owner.

L. In the event that rock (ledge) or other obstructions are encountered in a plant pit or bed excavation work, such obstructions shall be reported promptly to the Architect. Alternate plant locations may be selected by the Architect.

M. If surface water or excessively saturated plant pit soils exist, the Contractor shall immediately notify the Architect.

N. All plant beds shown on the Drawings shall have a spade-cut edge unless otherwise shown with edging as may be specified in Section 323000.

3.4 CLEANUP

A. Following the acceptance of planting work, the Contractor shall immediately remove from the site all materials and equipment not required for any other planting or maintenance work. Store materials and equipment remaining on site in locations which do not interfere with the Owner's maintenance of accepted work.

B. The Contractor shall be responsible for keeping all paving and building surfaces clean during placement of topsoil and planting operations. All excess stones, debris and soil resulting from work under this Section which have not previously been cleaned up shall be cleaned up and removed from the project site. Clean up spills and oversprays immediately. Acceptance shall not be granted until this condition is met.

3.5 WASTE MANAGEMENT – Coordinate with Section 017419

A. Separate and recycle materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.

B. Set aside and protect materials suitable for reuse and/or remanufacturing.

C. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.

** END OF SECTION **

330110.13 - PRESSURE AND LEAKAGE TESTING OF PIPELINES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Contractor shall pressure test all potable water pressure and sewer forcemain pipelines shown on the contract drawings. All piping and equipment shall be tested in the field in the presence of the Engineer.

B. Prior to testing, all mains shall be flushed and pigged to remove all sand and other foreign matter. Flushing shall be terminated at the direction of the Engineer. The Contractor shall dispose of the flushing water without causing a nuisance or property damage.

C. No testing shall be done until all joints are restrained. Temporary thrust blocks or reverse deadmen may be used with the Engineer's prior approval.

1.3 RELATED SECTIONS

A. Related Sections include the following:
   1. Division 33 Sections for buried pipe installation requirements.
   2. Division 33 Section "Disinfection of Pipelines" for disinfection testing requirements of pipelines.

1.4 SUBMITTALS

A. For closeout: Pressure Test Reports performed as well as any laboratory results received as part of this work. Specifically:
   1. Pressure Report:
      a. Hydrostatic Test Pressure.
      b. Dates and time for start and completion of pressure testing.
      c. Pressure results at start and finish of each section tested.
      d. Amount of Water Used during testing.
      e. Signature of person performing tests and signature of witness.

B. Certificate: Certify that pressure testing of water distribution system meets or exceeds requirements of the AWWA.

PART 2 – PRODUCTS

PART 3 - EXECUTION

3.1 GENERAL

A. All hydrant control valves must be open while pressure testing.

B. All blow-off standpipes and injection points shall be removed upon satisfactory completion of sampling and testing. Corporation stops shall remain in line.

C. Teflon tape shall be used on all threaded joints to avoid contamination (No pipe dope allowed).

D. It is the Contractor's sole responsibility to place sample points where designated by the Design Engineer.

E. The Contractor shall backfill all pipe and thrust blocking before pressure testing unless the Engineer directs certain joints or connections left uncovered. Where thrust blocking is provided the pressure test shall not be made until at least five days after the thrust blocking has been installed. A high early strength concrete may be used to reduce this time.

F. Each valved section of pipe shall be slowly filled with water and a pump shall be hooked to the pipe in a manner satisfactory to the Engineer to supply the test pressure. The pump, pipe connection and all necessary apparatus shall be furnished by the Contractor.

G. While the system is being filled with water, air shall be carefully and completely exhausted. If permanent air vents are not located at all high points, the Contractor shall install corporation stops or fittings and valves at such points so the air can be expelled as the pipe system is slowly filled with water. Service shall be tested as part of the main pipeline.

H. Source water that is from a public water supply shall use backflow protection. A double check valve assembly or better device approved by the New York State Department of Health is acceptable.

3.2 PRESSURE TEST FOR DUCTILE IRON AND PVC PIPING

A. All newly laid pipe, including fitting and valves shall be pressure tested by the Contractor, in accordance with the latest editions of AWWA C600 and C605, to verify the integrity of the pipeline.

B. Test pressures and durations shall be as follows:

	Pressure (psi)	Duration (hrs)
Sewage force main	150	2
Reclaimed water mains	150	2
Potable water mains	150	2
Fire mains	200	2

*Water mains should be tested at 1.5 times the working pressure.

C. A leakage test shall be conducted in the presence of the Engineer and, after the pressure test has been satisfactorily completed. The Contractor shall, as before, furnish all pumps, pipe, connections and other items required to satisfactorily complete the leakage test. The leakage test shall have a duration of two hours at the pressure specified for the pressure test. No pipe installation will be accepted if the leakage is greater than that determined by the formula for mechanical and push-on joints per hour:

$$L = \frac{SDP^{1/2}}{148{,}000}$$

L= Allowable leakage [gph]
S= Length of pipe tested [feet]
D= Nominal diameter of pipe [inches]
P= Average pressure during test [psig]

150 i (per 1000ft.) at 2 hours
(Per AWWA C600& AWWA C605 Tables)

Line Size (in)	Allowable Leakage (gal)
2	0.34
4	0.66
6	1.0
8	1.32
10	1.66
12	2.0
16	2.64
18	2.98
20	3.32
24	3.98
30	4.96
36	5.96
42	6.96
48	7.94
54	8.94

D. The Engineer, or his duly authorized representative, shall witness these tests. The Contractor shall be responsible for finding and repairing leaks. No additional cost may be incurred by the Owner due to repairs because of failure of the test. The Engineer has the authority to determine the number of repairs that will be made within a given length of pipe and has the right to request the Contractor to remove and relay a section of pipe if such does not comply with the established leakage rates as calculated using the formula above.

E. For the duration of the test, the pressure in the main shall not be allowed to drop more than 5 psi below the test pressure per AWWA C600 & C605. Should the pressure drop 5 psi, makeup water shall be added to the line to restore the pressure to the test pressure. This makeup water shall be measured and shall be included in the total leakage measured. If loss is greater than 5 psi, the test fails.

3.3 PRESSURE TESTING OF HDPE PIPELINES

A. Filled pipelines shall be allowed to thermally stabilize such that the temperature of the water and the pipe are equal. At temperatures above one hundred (100) degrees F, the Engineer shall be consulted regarding the need to reduce the test pressure.

B. The piping shall be tested between valved sections to a maximum length of five thousand (5,000) feet.

C. For any test pressure from 1.0 to 1.5 times the system design pressure, the total test time including initial pressurization, initial expansion, and time at test pressure, shall not exceed eight hours. If the pressure test is not completed due to leakage, equipment failure or other reason, the test section shall be depressurized, and allowed to “relax” for at least eight hours before bringing the test section up to test pressure again.

D. The test procedure consists of initial expansion, and the test phase:

1. During the initial expansion phase, the test section is pressurized to 10 psi above the test pressure (see Table A for Expansion Pressure), and sufficient make-up water is added each hour for three hours to return to the expansion phase pressure.
2. After the initial expansion phase, about four hours after pressurization, the test phase begins.
3. During the test phase, the pipe is stabilized at the test pressure (see Table A). The pressure shall remain steady within five percent of this target value for two hours. If the pressure falls below five percent of the test pressure (see Table A), leakage or insufficient expansion is indicated, and the test shall be repeated after the pipe is allowed to "relax" as indicated above. Make-up water is not allowed during the test phase.

TABLE A

Pipe Class (SDR)	Expansion Pressure (psi)	Test Pressure (psi)	5% Reduction Pressure (psi)
17	150	140	133
13.5	170	160	152
11	170	160	152
9	210	200	190

3.4 REPAIR

A. The Contractor shall repair all leaks in the piping at no cost to the Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement shall be made on the basis of lineal foot of pipe of the type and size(s) properly placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include all fittings and/or accessories not specifically included for measurement and payment under other items in the Proposal.

4.2 PAYMENT

A. Payment will be made at the unit price bid under the appropriate item(s) of the Proposal.

END OF SECTION 330110.13

SECTION 330516.13 – PRECAST CONCRETE UTILITY STRUCTURES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION:

A. The Contractor shall furnish all labor, materials, and equipment to provide AASHTO HS-25 rated underground precast concrete vaults and appurtenances; and install structures in locations as shown in the Contract Plans.

B. This Section includes structures including but not limited to the following:

1. Drainage system catch basins
2. Meter valve vaults/manholes
3. Pressure relief valve vaults/manholes
4. Box culverts
5. End walls
6. Pipe ends
7. Frames and covers
8. Risers
9. Access hatches
10. Vents
11. Sump Pumps

1.3 RELATED SECTIONS:

A. See Division 31 sections for excavation and backfill requirements.

1.4 SUBMITTALS:

A. Shop Drawings:

1. Indicate structure locations, elevations, sections, sizes and elevations of penetrations.
2. Indicate concrete mix design for each different mix.
3. Indicate design, construction and installation details, typical reinforcement and any additional reinforcement at openings.
4. Indicate design loads for each structure.
5. Crystalline waterproofing admixture manufacturer utilized, if applicable to structure.
6. Unless the experience requirement outlined in paragraph 1.7 below is met, a written notice from admixture manufacturer stating that technical help was provided to the precast manufacturer is required.

1.5 REFERENCES:

A. ASTM International:

1. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing

Bars.
3. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
4. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
5. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
6. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
7. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Section Precast Concrete Water and Wastewater Structures.
8. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
9. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
10. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test prior to Backfill.
11. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.

1.6 DELIVERY, STORAGE AND HANDLING:
- A. Deliver structures protective wrapping/coverings.
- B. Store products on elevated platforms in a dry location with protection from elements.
- C. Lift, support, and transport per manufacturer’s recommendations.

1.7 WARRANTY:
- A. Warranty period is one year after date of substantial completion of installation.

1.8 QUALITY ASSURANCE:
- A. Obtain precast concrete utility structures from single source.
- B. Perform structural design in accordance with ACI 318.
- C. Perform work in accordance with NPCA Quality Control Manual for Precast Plants.
- D. Conform to the following for material and fabrication requirements:
  1. Single Cell Box Culverts: ASTM C1433.
  2. Other Structures: ASTM C913.
  3. Manufacturer shall have a minimum of 10 years experience in the manufacture of precast structures of the type(s) called for on the Contract Drawings.

PART 2 -PRODUCTS

2.1 PRECAST CONCRETE UTILITY STRUCTURES:
- A. Acceptable Fabricators:
  1. OldCastle Precast
  2. Fort Miller
  3. LHV Precast
  4. Substitutions: Approved equal.

2.2 CONCRETE MATERIALS:
- A. Cement: ASTM C150, Type I, Portland type.
- B. Fine and Coarse Aggregates: ASTM C33, except gradation requirements do not apply.
- C. Water: Clean and not detrimental to concrete.

2.3 ADMIXTURES:
- A. Air Entrainment: ASTM C260
- B. Chemical Admixtures: ASTM C494/C494M
  1. Other chemical admixtures are allowed provided they shall not interfere with crystalline waterproofing admixture, if used.
- C. MANUFACTURERS:
  1. BASF Corporation-Construction Systems.
  2. Cortec Corporation.
  3. Euclid Chemical Company (The); an RPM company.
  4. General Resource Technology.
  5. Grace Construction Products; W.R. Grace & Co. -- Conn.
  6. Green Umbrella.
  7. Sika Corporation.
  8. Substitutions: Approved equal.

2.4 CONCRETE REINFORCEMENT:
- A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, plain billet bars, epoxy coated finish.

2.5 FRAMES AND COVERS:
- A. Manufacturers:
  1. Basis-of-Design: EJ Group, Inc.
  2. Barry Pattern & Foundry Co., Inc.
  3. McKinley Iron Works, Inc.
  4. Neenah Foundry
  5. Approved equal
- B. Product Description: Round lid, cast iron construction
  1. Lid: Machined flat bearing surface, removable lockable lid, live load rating of 300 psf; sealing gasket; cover molded with “Town of New Windsor Water”.
  2. Nominal lid Size: 30 inches diameter.

2.6 ACCESS HATCHES:
- A. Manufacturers:
  1. Basis-of-Design: Bilco Company (The).
  2. EJ Group, Inc.
  3. U.S.F. Fabrication
  4. Approved equal
- B. Access Hatch: Aluminum welded construction; size and configurations as noted on Contract Drawings.
  1. Models: Access hatches shall be PCM by Bilco or equal; Rigging hatches shall be PDCM by Bilco or equal.

2. Hatches shall be flood resistant or sealed and drained to deter water infiltration.
3. Cover: Diamond plate reinforced with structural stiffeners to support required loads.
4. Frame: Channel type with integral seat to support cover stiffeners; anchor flange around frame perimeter.
5. Hinges: Stainless steel.
6. Lift Handle: Flush drop handle, non-removable type mounted in cover.
7. Lifting Mechanism: Stainless steel compression springs with automatic hold open and dead stop to retain cover in open position. Cover springs to prevent contact by personnel entering utility structure.
8. Latch Mechanism: Stainless steel lock with external handle and permanent internal release mechanism.
9. Hardware: Stainless steel.
10. Finish: unfinished.
11. Signage: All hatch covers shall have a 10” x 7” bilingual English/Spanish “Danger - Confined Space” sign by Emedco or equal. Material shall be shall be self-adhesive vinyl with a Duroshield topcoat and non-reflective finish.

2.7 ACCESSORIES:

A. Steps: Formed polypropylene rungs.
   1. Diameter: 3/4 inch.
   2. Width: 12 inches.
B. Spacing: 16 inches on center vertically.
C. Inserted and Embedded Items:
   1. Structural Steel Sections: ASTM A36/A36M;
D. Joint Sealants and Joint Gaskets:
E. Gasket Joints for Circular Concrete Pipe: ASTM C443 (ASTM C443M); standard rubber gaskets.
   1. External Sealing Bands: ASTM C877 (ASTM C877M); Type III chemically bonded adhesive butyl bands.
   2. Preformed Joint Sealants for Concrete Pipe and Box Sections: ASTM C990.
   3. Elastomeric Joint Sealants: ASTM C920; silicone; Grade NS, Class 25;
F. Pipe Entry Connectors: ASTM C923 (ASTM C923M).
G. Grout:
   1. Cement Grout: Portland cement, sand and water mixture with stiff consistency to suit intended purpose.
   2. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400in 48 hours and 7,000 psi in 28 days.
H. Vents
   1. Vent piping shall be UV resistant PVC of the size indicated on the Contract Plans. Vents shall be a J-tube style and be equipped with a 20 mesh fiberglass insect screen.

2.8 SUMP PUMPS:

A. Sump pumps, if required, shall be shown on the contract plans or specified in 33 12 16.

B. Pumps shall be Pentair/Myers Model SSM33I or equal.
   1. Motors shall be a minimum 1/3 HP.
   2. Flow shall be a minimum rating of 28 gpm at 10' TDH.
   3. Pumps shall have thermal overload protection with automatic reset.
   4. Warranty shall be 2 years from date of manufacture.
   5. Pump shall have a FLA of 9 amps and operate on 115v, 60 Hz, 1 Phase power.
   6. Discharge size shall be 1.5" NPT.

2.9 CONCRETE MIX:
   A. Select proportions for normal weight concrete in accordance with ACI 318 and ACI 211.1.
   B. Provide concrete to the following criteria:
      1. Compressive Strength: 4,000 psi at 28 days.
      2. Water Cement Ratio:
         a. Concrete Exposed to Freezing and Thawing: Maximum 0.45 percent by mass.
   C. Air Content:

Maximum Aggregate Size inches (mm)	Air Content, Percent	
	Severe Exposure	Moderate Exposure
3/8 inches (9 mm)	6.0 to 9.0	4.5 to 7.5
1/2 inches (13 mm)	5.5 to 8.5	4.7 to 7.0
3/4 inches (18 mm)	4.5 to 7.5	3.5 to 6.5
1 inches (25 mm)	4.5 to 7.5	3.0 to 6.0
1-1/2 inches (38 mm)	4.5 to 7.0	3.0 to 6.0

2.10 ADMIXTURES:
   A. Include other admixture types and quantities indicated in concrete mix designs approved through submittal process.
   B. Do not use calcium chloride.
   C. Admixtures utilized shall not interfere with the crystalline waterproofing admixture.

2.11 FABRICATION:
   A. Fabricate precast concrete utility structures in accordance with ACI 318. and NPCA Quality Control Manual for Precast Plants.
   B. Fabricate precast concrete utility structures to size, configuration, and openings as indicated on Drawings.
   C. Construct forms to provide uniform precast concrete units with consistent dimensions.
   D. Clean forms after each use.
   E. Install reinforcing by tying or welding to form rigid assemblies. Position reinforcing to maintain minimum 1/2 inch cover. Secure reinforcement to prevent

displacement when placing concrete.

F. Position and secure embedded items to prevent displacement when placing concrete.
G. Deposit concrete in forms. Consolidate concrete without segregating aggregate.
H. Provide initial curing by retaining moisture using one of the following methods:
   1. Cover with polyethylene sheets.
   2. Cover with burlap or other absorptive material and keep continually moist.
   3. Apply curing compound in accordance with manufacturer's instructions.
   4. Provide final curing in accordance with manufacturer's standard.
   5. Remove forms without damaging concrete.

PART 3 – EXECUTION

3.1 EXAMINATION:
A. Verify items provided by other sections of Work are properly sized and located.
B. Verify correct size and elevation of excavation.
C. Verify subgrade and bedding is properly prepared, compacted and ready to receive Work of this section.

3.2 PREPARATION:
A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
C. Inspect precast concrete structures immediately prior to placement in excavation to verify are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION:
A. Install underground precast utility structures in accordance with ASTM C891.
B. Lift precast concrete structures at lifting points designated by manufacturer.
C. When lowering structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.
D. Install precast concrete utility structures to elevation and alignment indicated on Drawings.
E. Assemble multi-section structures by lowering each section into excavation.
F. Clean joint surfaces.
G. Install watertight joint seals in accordance with manufacturer's instructions using elastomeric joint sealants.
H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with grout.
I. Connect pipe to structure and seal watertight. Cut pipe flush with interior of structure if called for on Contract Drawings.
J. Grout base to achieve slope to exit piping if called for on Contract Plans. Trowel smooth. Contour to form continuous drainage channel.
K. Set frame and cover/access hatch level without tipping, to elevations indicated on Drawings.
L. Connect drain from access hatch frame to drain to daylight down gradient from

cover.

M. Backfill excavations for structures in accordance with Section 312323.

3.4 FIELD QUALITY CONTROL:

A. Perform one of the following tests and inspections for structures:

1. Vacuum Test: ASTM C1244 (ASTM C1244M) for round structures; ASTM C1227 for non-circular structures.
2. Hydrostatic Exfiltration Test per ASTM C990 for round structures; ASTM C1227 for non-circular structures.

END OF SECTION 330516.13

SECTION 330531.11 - POLYVINYL CHLORIDE (PVC) PIPE FOR NON-PRESSURE SEWER SERVICE

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. This specification section includes all materials, equipment, labor, and incidentals required for the supply and installation of polyvinyl chloride (PVC) pipe and fittings, 4-inch diameter to 60-in diameter for use in storm sewer, sanitary sewer, or other non-pressure sewer applications.

1.2 RELATED SECTIONS:

A. Trenching, Backfilling, and Compaction Work – Section 312333

1.3 REFERENCES:

A. The Contractor and/or Pipe Manufacturer shall follow the standards listed below, except as otherwise specified herein. The latest revision or edition in effect at the time of bid opening shall be utilized.

B. American Society for Testing and Materials (ASTM)
   1. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
   2. D2321 – Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications
   3. D3034 – Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
   4. D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
   5. F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe
   6. F679 – Polyvinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
   7. F1417 – Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

C. American Water Works Association (AWWA)
   1. M23 – PVC Pipe – Design and Installation

D. Uni-Bell PVC Pipe Association
   1. UNI-B-6 – Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
   2. UNI-PUB-6 – Installation Guide for PVC Solid-Wall Sewer Pipe (4 - 48 in.)
   3. UNI-TR-3 – Maintenance of PVC Sewer Pipe
   4. Handbook of PVC Pipe Design and Construction

1.4 QUALIFICATIONS:

A. The Pipe Manufacturer shall be a member of the Uni-Bell PVC Pipe Association.

B. The pipe and fittings shall be designed, manufactured, and installed in accordance with industry standards and shall comply with the specification requirements herein.

1.5 SUBMITTALS:

A. Submit product data on pipe, fittings, gaskets and appurtenances as required to ensure products meet the requirements of this specification.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Pipe shall be shipped so as to not bend, dent, or otherwise damage the pipe during transport.
B. Contractor shall take all necessary precautions to prevent damage to pipe and fittings during delivery and unloading.
C. Owner shall observe and inspect unloading of pipe to ensure proper unloading procedures are followed.
D. Under no circumstances will pipe be allowed to be rolled, pushed, or dropped off from any height for delivery, storage, or installation. Any pipe found to have been damaged due to improper handling procedures truck will be immediately marked for identification and removed from the jobsite at the Contractor's expense.
E. Stacking of pipe shall be performed in accordance with Pipe Manufacturer's recommendations.
F. Once pipe has been unloaded, it shall be stored as near to its point of installation as possible. Contractor shall limit moving or restacking of pipe prior to installation.
G. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
H. Pipe shall not be stored close to heat sources or hot objects such as heaters, boilers, steam lines, and engine exhaust.
I. If pipe is to be exposed to direct sunlight for extended periods (in excess of two years from the date of manufacture), then Contractor shall cover/shade pipe utilizing canvas or other opaque materials. Black plastic will not be acceptable as a shading material.
J. Gaskets shall be protected from exposure to excessive heat, prolonged direct sunlight, and oil and grease.
K. Material storage shall be performed in accordance with Pipe Manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 PIPE:

A. Pipe shall be manufactured and supplied in accordance with ASTM D3034 (4-Inch to 15-Inch) or F679 (18-Inch to 60-Inch).
B. Pipe should have a standard dimension ratio (SDR) of SDR 35.
C. Pipe shall have lay lengths between 14 and 22 feet unless otherwise specified by the Owner.
D. The pipe shall be made of PVC compound having a cell classification of 12454 or 12364 in accordance with ASTM D1784.
E. Pipe shall be homogenous throughout, free of voids, cracks, inclusions, and other defects.
    1. Pipe shall have markings at intervals of 5ft or less including:
    2. Manufacturer's name or trademark and code

3. Nominal pipe size
4. PVC cell classification
5. Legend (e.g. " SDR-41 PVC Sewer Pipe" or "PS 46 PVC Sewer Pipe")
6. ASTM Designation
7. Gasketed pipe shall be marked with an insertion depth mark on the spigot end.

F. Pipe for non-potable water and wastewater uses shall be green or white in color.

G. Pipe outside diameters shall be equal to those of cast iron unless otherwise specified by the Owner.

2.2 PIPE DESIGN:

A. Pipe shall be supplied to meet the external loading requirements of the project as follows:
1. Maximum calculated deflection of 7.5%
2. Live loads as calculated per AWWA M23 based on the profile shown on the plans
3. Depth of cover as shown on the plans
4. Trench width as shown on the plans
5. Modulus of soil reaction (E'), bedding constant (K), and soil density (γ) shall be based on design and site conditions.

2.3 FITTINGS:

A. Fittings shall be manufactured and supplied in accordance with ASTM D3034 (4-Inch to 15-Inch) or ASTM F679 (18-Inch to 60-Inch). Molded and fabricated fittings may be supplied in accordance with ASTM F1336.

B. Fittings shall be made of PVC compound having a cell classification of 12454 or 13343 in accordance with ASTM D1784.

C. Pipe used in fabricated fittings shall have a wall thickness equal to or greater than the wall thickness of the pipes to which the fitting (or that part of the fitting) will be joined.

D. Molded and fabricated fittings shall have markings including:
1. Manufacturer's name or trademark
2. Nominal size
3. Material designation (e.g. "PVC")
4. ASTM Designation

E. Fittings may also be supplied as ductile iron fittings in accordance with AWWA C110 and/or C153.

2.4 PIPE JOINTS:

A. Joints shall be gasketed push-on type conforming to ASTM D3212.

B. Gasket materials shall meet requirements of ASTM F477.

C. Joint lubricant shall be approved by the Pipe Manufacturer and shall have no detrimental effect on the gasket or pipe.

PART 3 - EXECUTION

3.1 GENERAL:

A. Install pipe, fittings, specials, and appurtenances in accordance with ASTM D2321, UNI-PUB-6 and/or in accordance with the Pipe Manufacturer's recommendations.
B. Lay pipe to the lines and grades as indicated on the Plans.

3.2 PIPE HANDLING:

A. Handle pipe and piping materials with care to avoid damage.
B. Prior to installation, each pipe length shall be carefully inspected for damage.
C. All pipe, fittings, and appurtenances shall be thoroughly cleaned before installation and shall be kept clean until installation and backfilling has completed.
D. Use only nylon ropes, slings, or other lifting devices that will not damage the surface of the pipe.
E. Keep the pipe clean and free of debris, dirt, animals, and trash during and after laying operations.
F. At the close of each operating day, seal the open end of the pipe using a gasketed night cap.

3.3 PIPE INSTALLATION:

A. Do not drag pipe over gravel or rock. Avoid striking rocks or hard objects when lowering pipe into the trench.
B. Placement of pipe and fittings into the trench should be done with ropes and skids, slings on a backhoe bucket, or by hand.
C. Pipe or fittings shall not be thrown into the trench and no part of the pipe shall be allowed to take an unrestrained fall onto the trench bottom.
D. Joint sockets shall be carefully cleaned before pipes are lowered into trenches.
E. Pipe trenches and excavation shall be kept free of water during pipe laying operations and other related work. If high groundwater levels are expected or encountered, Contractor is to ensure that a minimum depth of cover of 1.5 times the pipe diameter will be maintained over the pipe once it has been installed or provide other methods approved by the Owner and Pipe Manufacturer of preventing flotation of the pipe.

3.4 JOINT MAKING:

A. Install push-on joints in accordance with Pipe and Fittings Manufacturer's recommendations.
B. Inspect the gasket, pipe spigot bevel, gasket groove, and sealing surfaces for damage or deformation. In cases when gaskets are supplied separately from pipe, Contractor is to ensure that gaskets supplied are designed for the pipe in use.
C. Clean the gasket of all extraneous matter.
D. Apply a thin film of joint lubricant to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell. Lubricated spigots ends shall not come in contact with soil or backfill material.
E. Insert the spigot end of the pipe carefully into the bell until the reference mark on the spigot is flush with the bell. If two reference marks are present, the mark closest to the spigot end shall be considered the minimum insertion mark, and the second mark shall be considered the maximum insertion mark. Under no circumstances will the spigot be inserted into the bell past the reference mark or maximum insertion mark.

F. For small diameter pipe, use the bar-and-block method for joint assembly or other method approved for use by the Owner and Pipe Manufacturer.
G. For large diameter pipe, use mechanical assistance such as hydraulic pipe pullers, jacks, pulleys, come-alongs, or a backhoe bucket. Observation by a spotter will be required when assembling joints for large diameter pipe to prevent over-insertion.
H. When using a field cut plain end piece of pipe, bevel the end with a beveling tool, wood rasp, or power sander to the same angle and length as provided on the factory-finished pipe. Redraw the insertion line on the spigot using a factory-marked spigot as a guide.
I. Angular changes in pipe alignment shall be achieved by either fittings, joint deflection, or longitudinal bending of the pipe.
J. Joint deflection shall not exceed the Pipe Manufacturer's recommendation.
K. Field assembly of pipe fittings shall follow the Pipe Fittings Manufacturer's recommendations.
L. Mechanical joints shall be assembled per the Pipe and/or Fittings Manufacturer's recommendations as well as the recommendations of the mechanical joint supplier.

3.5 LONGITUDINAL PIPE BENDING:
A. Controlled changes in direction may be accomplished by longitudinal bending of the pipe barrel.
B. Pipe Manufacturer shall be consulted prior to start of construction for recommendations on longitudinal bending.
C. When longitudinal bending of pipe is utilized, Contractor shall use manual force alone to achieve prescribed bending. Mechanical means shall not be utilized to achieve longitudinal bending of the pipe.
D. When the desired change of direction in the pipeline exceeds the maximum allowable deflection specified, the longitudinal bending shall be made throughout a number of pipe lengths.
E. Contractor will ensure that pipe joints will not be over-pulled or over-inserted during longitudinal bending operations.

3.6 FIELD TESTING:
A. After pipe has been installed and backfilled, deflection testing shall be performed in accordance with ASTM D3034 and/or F679, PVC Pipe Handbook, and the specifications herein. Deflection testing shall utilize a "go/no-go" mandrel for measurement of pipe deflection. Contractor shall allow for stabilization of the pipe/soil system (minimum of 30 days) prior to testing.
B. All finished installations for non-pressure applications shall be tested via low-pressure air testing in accordance with ASTM F1417, UNI-B-6, and the specifications herein.
C. Isolate the section of non-pressure sewer line to be air tested by inflatable stoppers or other suitable test plugs/caps.
D. Ends of all branches, laterals, tees, wyes, and/or stubs in the test section shall be plugged or capped to prevent air leakage. One of the plugs/caps shall have an inlet tap or other method for connecting the air hose to an air control source.

E. Test ends should be restrained and/or braced during air testing.
F. Add air slowly to the test section until the pressure reaches 4.0 psi. After the test pressure is obtained, regulate the air supply so that the pressure is maintained between 3.5 and 4.0 psi for at least 2 minutes until the air temperature stabilizes and is in equilibrium with the temperature of the pipe walls.
G. After equilibrium is achieved, determine the rate of air pressure loss by either the constant pressure method or the time-pressure drop method as outlined in ASTM F1417.
H. Upon completion of the test, open the bleeder valve and allow all air to escape. Caps/plugs shall not be removed until all air pressure in the test section has been reduced to atmospheric pressure.

PART 4 - MEASUREMENT AND PAYMENT:

4.1 MEASUREMENT:
A. Measurement shall be made on the basis of lineal foot of PVC water pipe of the type and size(s) properly placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include all fittings and/or accessories not specifically included for measurement and payment under other items in the Proposal.

4.2 PAYMENT:
A. Payment will be made at the unit price bid under the appropriate item(s) of the Proposal; the price bid shall include ,excavation, shoring, dewatering, disposal, bedding, NYSDOT sub-base backfill, compaction, compaction testing, thrust blocks, retaining rods, fittings and specials, including reducers, disinfection, testing and sampling, restoration; identification tape, locating wire, record drawings, miscellaneous work, including connection to existing mains and appurtenances, abandonment of existing mains, as required to complete the work.

END OF SECTION 330531.11

SECTION 331113.13 DUCTILE IRON (D.I.) WATER PIPE AND SPECIALS (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide and install ductile cast iron pressure water pipe and specials, with end types (mechanical joint, flanged, push-on or ball and socket) as called for or shown with integral wall bell and spigot joints.

1.2 RELATED WORK:

A. Trenching, Backfilling and Compaction - Section 312333
B. Pressure and Leakage Testing of Pipelines – Section 330110.13
C. Disinfection Testing of Pipelines – Section 331301

1.3 EXISTING CONDITIONS

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 PIPE (GENERAL):

A. All pipe shall be centrifugally cast.
B. Shall be coated on the outside and cement-lined.
C. Shall be in nominal eighteen (18) feet laying lengths, according to the Manufacturer's standard practice.
D. Shall be Class 52, unless otherwise indicated, suitable for a working pressure of 350 psi.
E. The weight, class or nominal thickness and casting period shall be shown on each pipe.
F. The manufacturer's mark, the year in which the pipe was produced and letters "DI" or "Ductile" shall be cast or stamped on each pipe.

2.2 DEFINITIONS:

A. "Pipe" - all straight sections
B. "Specials" - all branches, bends, tees, other fittings, reducers, etc.
C. Straight pipe which is cut to fit to work, or short sections of straight pipe, will not be considered specials.
D. All cast iron specials shall be Class 250, shall have the same type ends and shall be in accordance with the Specifications for the pipe with which they are to be placed unless specifically indicated otherwise.

2.3 PIPE (JOINTS AND FITTINGS):

A. Mechanical Joint Pipe:
   1. Joint shall meet all requirements of American standard Specifications for

Mechanical Joints, A21.11 "year of latest revision".

2. Shall have the same pressure rating as the pipe of which it is part.
3. Bell of mechanical joint shall be cast integrally with the pipe and shall meet the applicable requirements of the specifications under which the pipe is produced.
4. The iron in the glands shall meet the requirements of Class 25 of American Standard Specifications for gray iron cast, ASA G25.1, or most recent revision thereof.
5. The annular surfaces of the gland lip and the bolt circle, shall be concentric and tolerances shall be given by the American Standard Specifications for Mechanical Joints, A21.11 - 1964, or "year of latest revisions".
6. The surface of the gland shall be smooth and free from defects of every nature which would unfit them for the use intended.
7. Glands shall be coated with a bituminous dip or paint, unless otherwise specified.
8. Gaskets shall be vulcanized natural or vulcanized synthetic rubber and shall be in accordance with American Standard Specification A21.11 "year of latest revision". No reclaimed rubber shall be used. When two (2) hardnesses of rubber are included in a gasket, the soft and hard portions shall be integrally molded and joined in a strong vulcanized bond. They shall be free of porous areas, foreign material, and visible defects. Tests shall be made by the manufacturer in accordance with the applicable ASTM Test Methods. Gaskets shall be Rainbow, Durable, Garlock or "approved" equal.
9. The mechanical joint for ductile iron pipe shall meet all the requirements of the American Standard Specifications for Mechanical Joints A21.11 "year of latest revision", and shall have the same pressure rating as the pipe of which it is a part.
10. The bell of the mechanical joint shall be cast integrally with the pipe and shall meet the applicable requirements of the specifications under which the pipe is produced.

B. Push-on Joint Pipe:
   1. Joint shall meet all requirements of ANSI A21.11 "year of latest revision" (AWWA C111) for the rubber gasket joints.
   2. All joints shall be provided with two (2) serrated bronze wedges at the 10 o'clock and 2 o'clock positions in accordance with the pipe manufacturer's standards. Wedges shall insure electrical conductivity throughout the entire length of pipeline.

C. Flanged Pipe (Only utilized where specifically called for or required):
   1. To be provided where specifically indicated on the Plans or called for in the Specifications.
   2. Shall be of the water pattern, as under American Standard Association Specification 3.6.1, Class 125 or Class 250 (as indicated), latest revision.
   3. Shall conform to ANSI A21.10 (latest revision).
   4. All flanged pipe ends and fittings shall be faced and drilled in accordance

with the aforementioned standard.

5. The gasket material, bolts and nuts, and all other items necessary to provide a complete installation of flanged pipe and fittings shall be provided and included.

D. Ball and Socket (Only utilized where specifically called for or required):
   1. To be provided where specifically indicated on the Plans or called for in the specifications.
   2. Shall be suitable for usage on the water system shown.
   3. Joints shall be boltless, push-on, with bayonet-type locking retainer and capable of deflections to a maximum of 5 degrees.
   4. Joint bell, ball and retainer shall be of cast 70-50-05 ductile iron in accordance with ANSI A21.20 (year of latest revision).
   5. Pipe components shall be machined to precise tolerances to assure premium performance and ease of assembly.
   6. Gasket shall be of high quality rubber and symmetrical to insure it cannot be installed backwards.
   7. Pipe shall be ductile iron of cast 60-42-10 in accordance with ANSI A21.51.
   8. Pipe shall be of the thickness class number to overcome buoyancy.
   9. Pipe shall be cement-lined, bituminous coated, 18' lengths and conform to all other requirements under this section, unless otherwise noted.

2.4 STANDARDS:

A. All pipe and fittings shall at minimum meet all the applicable requirements of the American Water Works Association (AWWA) as well as the Standard Design and Construction Requirements for Water Distribution Main Extensions for the Town of Newburgh Consolidated Water District.

B. Pipe shall conform to American National Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds, for the water or other liquids of AWWA Specifications C151, year of latest revision.

C. All the ductile cast iron pipe and fittings shall be cement-lined in accordance with "American Standard Specifications for Cement Mortar Lining for Cast Iron Pipe and Fittings, A21-4 "year of latest revision" or AWWA C104.

D. Bituminous seal coat shall be applied over the cement lining as specified in A.S.A. Specification A21.4 "year of latest revision.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL

A. All pipe must be installed in accordance with AWWA Standard C600, year of latest revision.

B. All pipe and fittings shall be placed as shown on the plans and in compliance with the requirements of the specifications.

C. All pipe shall be installed and assembled in accordance with the manufacturer's recommendations.

D. All materials used in the construction shall be lead free in accordance with the 2014 “Lead Free” law.

3.2 INSPECTION OF PIPE

A. Previous to being lowered into the trench, each pipe and fittings or coupling shall be carefully inspected, and those not meeting the specifications shall be rejected and immediately removed from the project site and replaced with acceptable materials. Such replacement shall be made at no cost to the Owner.

B. Movement of construction equipment and all other vehicles and loads over and adjacent to any pipe shall be done at the Contractor's risk. Any pipe, which in the judgement of the Engineer is damaged or disturbed through any cause, shall be replaced at the expense of the Contractor and at no cost to the Owner.

3.3 PIPE PLACEMENT (GENERAL):

A. Pipe lines shall be placed in the locations and grades as indicated on the Plans and in conformance with this Specification.
B. Trenches shall be kept free from water, and no pipe shall be laid in water.
C. Every effort shall be made to prevent any contaminating materials from entering the watermain during storage, construction or repair.
D. Pipe shall be so laid as to be evenly supported throughout the whole length of the barrel, with no weight resting on the bell or coupling. "Bell holes" shall be provided so that bells or couplings of pipe hang free.
E. If the trench is dug deeper than the grade of the barrel, no spalls, shims or lumps shall be used to raise the pipe to the grade, but an even bed shall be formed of sand or accepted fine material properly tamped at no additional expenses to the Owner.
F. In all cases where piping is being installed below the ground surface, before leaving the work for the night or any other time, the end of the pipe shall be securely closed with a watertight tight-fitting plug, and sufficient backfilling placed to protect the pipe.
G. When pipe is under pressure, and as indicated by the Engineer, reaction or thrust blocks shall be applied on all pipe lines size four (4) inches in diameter or larger at all tees, plugs, caps, and joints deflecting 22-1/2 degrees or more.
H. Tie rodding shall be done using pipe clamps manufactured for this purpose with minimum of 2-3/4" diameter steel rods. Thrust blocks shall be provided for any bends 22-1/2 degree or greater. Thrust blocks shall comply with the details shown on the plans (if no such details are shown, dimensions shall meet Engineer's requirements). All costs of furnishing and placing such thrust blocks or tie rods shall be at the expense of the Contractor, and shall be included in the price bid under these items.

3.4 PIPE PLACEMENT (FOUNDATION):

A. All pipe shall be laid on a foundation of compacted Crushed Stone Foundation to the minimum dimensions noted on the detail on the Plans.

B. If in the opinion of the Engineer the subgrade will not properly support the pipe, additional crushed stone materials shall be provided as necessary to provide a firm pipe bedding as acceptable to the Engineer.
C. Ground conditions such as quick sand, other soft and yielding or otherwise unsuitable material shall be immediately brought to the Engineer's attention such that evaluation of the necessary bedding can be made.
D. The Contractor is advised that additional crushed stone foundation material shall only be placed where required for the Engineer's acceptance of the work.
E. All Crushed Stone Foundation material shall conform to the requirements of the applicable technical section of the Specifications.

3.5 PIPE PLACEMENT (LOCATION & GRADE):

A. The pipe or invert grade referred to in the specifications and as indicated on the plans is the lowest point of the pipe invert or flow line.
B. Pipe shall be placed in the location and at exactly the lines and grades indicated on the plans.
C. The Engineer shall have the power to require the removal or relaying of any pipe laid contrary to the plans during his absence or that of his assistants or the Project Representative from the project site.
D. Grade or alignment shall not be disturbed by the operation of tamping or backfilling. Care must be taken not to disturb the pipes by stepping on or near them, or by throwing earth on them from the bank or otherwise.
E. The pipes and fittings or couplings shall be so laid in the trench that after the line is completed the interior surface thereof shall conform accurately to the grade and line required by the Engineer, and as indicated on the plans.
F. Contractor must transfer line and grade to "batter boards" and string line over the trench. The Contractor may not transfer line and grade to and/or utilize a "side line" or string set to line and grade other than over and above the center line of the pipe to be laid.
G. Other methods of Grade and Alignment control are subject to acceptance by the Engineer.

3.6 PIPING JOINTS:

A. Mechanical:
1. Joints shall be installed in full conformance with the manufacturer's recommendations.
2. Spigot end of the pipe shall be thoroughly brushed with a wire brush and then the gasket and spigot end of the pipe shall be brushed with soapy water. Cast iron gland shall then be slipped on the spigot end of the pipe with lip extension toward the joint. The gasket shall then be slipped on with the thick edge of the gasket toward the gland. The bell end of the joint shall then be thoroughly brushed and the pipe inserted into the bell. The gasket shall then be pushed into position so that it is evenly seated in the socket of the bell. The gland shall then be moved into position against the face of the gasket. Bolts shall then be inserted, the nuts placed, and made up tightly with the fingers. Nuts shall then be tightened gradually, half turn at a time,

using a torque-limited wrench of suitable size for the bolt sizes used, moving it from one nut to another and repeating until all nuts are uniformly tight. Torque limits of the bolts shall be in accordance with the pipe manufacturer's recommendations.

B. Push-On:
   1. Joints shall be installed in full conformance with the manufacturer's recommendations.
   2. The inside of the bell and outside of the spigot end shall be thoroughly cleaned and to remove oil, grit, excess coating and other foreight matter. The circular rubber gasket shall be flexed inward and inserted in the gasket recess of the bell socket. A thin film of gasket lubricant shall be applied to either the inside surface of the gasket or the spigot end of the pipe, or both. Gasket lubricant shall be as supplied by the pipe manufacturer and accepted by the Engineer. The spigot end of the pipe shall be entered into the socket with care used to keep the joint from contacting the ground. The joint shall then be completed by forcing the plain end to the bottom of the socket with a forked tool or jack-type tool or other device acceptable to the Engineer. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Field cut pipe lengths shall be filed or ground to assemble the spigot end of such pipes as manufactured. Assemble instructions of the manufacturer shall be followed where not in conflict with the foregoing.

3.7 DISINFECTION:

A. All elements of water line construction installed or disturbed under this contract when complete, shall be disinfected in accordance with these specifications, all applicable requirements of the local, county and state health department and AWWA Standard C651 and C653 (latest revision).

B. The method of disinfection shall be in accordance with the methods outlined in the Attachment provided hereto these documents a copy of AWWA Standard for Disinfecting Water Mains C651 except that disinfection in accordance with Section 4.3, TABLET METHOD, is not acceptable.

C. The basic disinfection procedure consists of:
   1. Removing, by flushing or any approved method necessary, any materials that may have entered the watermain.
   2. Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
   3. Protecting the existing distribution system from backflow due to hydrostatic pressure test and disinfection procedures.
   4. Determining the bacteriological quality by laboratory test after disinfection.
   5. Redisinfection, if necessary.
   6. Final connection of the approved new watermain to the active distribution system.

D. When the project includes existing mains which are wholly or partially dewatered, special disinfection procedures in accordance with Subsection 3.9 (hereunder) and the provisions of Section 4 of AWWA C651 shall be utilized.

3.8 TESTING:

A. Sequence of Testing:
   1. The hydrostatic test and leakage test shall be performed prior to disinfection to preclude the possibility of having to redisinfect if any repairs are necessary.

B. Hydrostatic Test:
   1. After the water mains have been installed and before pipe joints, fittings, valves or other appurtenances are covered, all of the excess air shall be expelled and the water main shall be pressure tested.
   2. Under the pressure test, hydrostatic pressure shall be equivalent to a pressure of 50% above normal operating pressure, based on the elevation of the lowest point on the line or section under test and corrected to the elevation of the test gauge.
   3. In no instance shall the pipe lines be tested at a pressure less than 150 psi, nor at a pressure exceeding 175 psi.
   4. The pressure test shall be at least two hours in length, preferably before complete backfilling of the pipeline, when the joints are exposed.
   5. All visible leaks, any cracked or defective pipe, fittings, valves, or hydrants discovered in consequent of the pressure test shall be removed and replaced by the Contractor with sound material; and the test shall be repeated until results satisfactory to the Engineer are obtained.
   6. The Contractor shall furnish all necessary appliances and make the test at his own expense.

C. Leakage Test:
   1. Leakage test shall be conducted concurrently with the pressure test.
   2. Leakage is defined as the quantity of water to be supplied into the newly laid pipe or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
   3. The leakage test shall be performed in accordance with AWWA Standard C600 "year of the latest revision" as well as the Standard Design and Construction Requirements for Water Distribution Main Extensions for the Town of Newburgh Consolidated Water District.
   4. There shall be no leakage during the test. The test pressure during the leakage test and the duration shall be the same as the hydrostatic test and shall be maintained within 5 psi.
   5. The Contractor shall furnish all necessary appliances and make the test at his own expense.

D. Bacteriological Testing:
   1. After the piped system has been disinfected and thoroughly flushed, but before the new water lines are final connected to the distribution system or placed in service, the water shall be tested for bacteriological quality and shall show the absence of coliform organisms.
   2. Two (2) consecutive sets of acceptable samples, taken at least 24 hours apart shall be collected from the new main. At least one set of samples shall be collected from every 1200 ft. of new watermain, plus one set from the end of the line and at least one set from each branch.

3. Samples shall be collected in sterile containers treated with sodium thiosulfate in accordance with the procedures of the "Standard Methods for the Examination of Water and Wastewater". Samples shall be collected by qualified personnel from sampling taps installed on the main. No hose or fire hydrant shall be used in the collection of samples.
4. Samples shall be tested by a laboratory approved by the New York State Department of Health for bacteriological testing acceptable to the Engineer. Original signed copies of the results of these tests shall be submitted in writing to the Engineer.
5. All samples shall be tested for bacteriological quality in accordance with "Standard Methods for the Examination of Water and Wastewater", and shall show the absence of coliform organisms. A standard heterotrophic plate count may be required at the option of the Owner and/or Engineer.
6. Sufficient samples shall be collected and tested from the various portions of the system to indicate, to the satisfaction of the Engineer, that a uniform representative sample has been obtained and tested.
7. If samples tested fail to produce satisfactory results, the main shall be reflushed and resampled, and, if necessary, redisinfected as called for in Section 5.1.6 of C651 (latest revision).
8. If trench water has entered the new main during construction or, if in the opinion of the Owner and/or Engineer, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 ft and shall be identified by location. Samples shall be taken of water that has stood in the new main for at least 16 hours after final flushing has been completed.
9. The Contractor shall furnish all necessary appliances and make the test at his own expense.

3.9 SPECIAL DISINFECTION PROCEDURES (FOR CUT-INS OR REPAIRS TO EXISTING MAINS):

A. The procedures referenced herein primarily apply to those cases when existing mains are wholly or partially dewatered or, where in the opinion of the Engineer, conditions warrant utilization of these special procedures.

B. When an existing main is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Provisions shall be made to provide such chlorination in these cases.

C. The interior of all pipe and fittings (particularly couplings and sleeves) used in making the repair or installation shall be swabbed or sprayed with a 1 percent hypochlorite solution before they are installed.

D. The Contractor shall utilize thorough flushing as an effective and practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water is eliminated. At least 24-hour prior notice shall be made to the Owner and Engineer before any flushing is performed.

E. After the appropriate procedures have been completed, the existing main may be returned to service prior to completion of bacteriological testing in order to minimize the time customers are out of water.

F. Bacteriological samples shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is unknown, then samples shall be taken on each side of the main break (or cut-in installation). If positive bacteriological samples are recorded, then the situation shall be evaluated with the Engineer and Owner, at which time corrective actions shall be determined and then taken by the Contractor. Daily sampling shall be continued by the Contractor until two consecutive negative samples are recorded.

PART 4 - MEASUREMENT AND PAYMENT:

4.1 Measurement shall be made on the basis of lineal foot of ductile iron water pipe of the type and size(s) properly placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include all fittings and/or accessories not specifically included for measurement and payment under other items in the Proposal.

4.2 Payment will be made at the unit price under the appropriate items(s) of the Proposal; the price bid shall include excavation, crushed stone foundation, backfill in a manner acceptable to the Engineer, including all labor, materials, fittings, equipment, rodding and thrust blocks, all "specials" and appurtenances, disinfection, testing and other work, miscellaneous work as called for or shown, as required to complete the work.

END OF SECTION 331113.13

SECTION 331113.23 - POLYVINYL CHLORIDE (PVC) WATER PIPE AND SPECIALS (NY)

PART 1 - GENERAL

1.1 WORK INCLUDED:
A. Provide and install unplasticized polyvinyl chloride (PVC) pressure water pipe and specials, with integral wall bell and spigot joints.

1.2 RELATED WORK:
A. Crushed Stone Foundation - Section 321123
B. Trenching, Backfilling and Compaction - Section 312333

1.3 EXISTING CONDITIONS:
A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 PIPE (GENERAL):
A. All pipe shall be unplasticized polyvinyl chloride (PVC) pressure water pipe.
B. Pipe shall have integral wall bell and spigot joints.
C. The pipe stiffness using F/Y for PVC Class 150 water pipe shall be SDR 18, F/Y = 435.
D. Class 150 pipe shall have a minimum burst test pressure of 755 psi.
E. The pipe (at 73 degrees F) shall be capable of being subjected to an impact from a falling 12" missile with a 2" radius nose in accordance with ASTM Method of Test D2444. No shattering or splitting shall be evident when 120 ft. - lbs. of energy is impacted.
F. Standard laying length shall be twenty (20) feet for all sizes (+ one (1) inch).
G. The manufacturer's mark, the year in which the pipe was produced and the classification of the pipe shall be stamped on each pipe.

2.2 DEFINITIONS:
A. "Pipe" - all straight sections.
B. "Specials" - all branches, bends, tees, other fittings, reducers, etc.

2.3 PIPE (JOINTS AND FITTINGS):
A. The bell shall consist of an integral wall section with a solid cross section, elastomeric ring, which meet the requirements of ASTM D1869 and F477.
B. The bell section shall be designed to be at least as strong as the pipe wall.
C. Provisions must be made for contraction and expansion at each joint with an elastomeric ring.
D. All fittings and accessories shall be as manufactured and furnished by the pipe supplier or equal and shall have a bell and/or spigot configuration compatible with that of the pipe.

E. As an option, cast iron Class 250 fittings and accessories may be used, providing they are compatible with the PVC pipe.

2.4 STANDARDS:

A. Pipe and fittings shall meet the requirements of AWWA Specification C900 "Polyvinyl Chloride (PVC) Pressure Pipe".
B. All pipe shall be Class 150 and shall meet the requirements of SDR 18.
C. All (PVC) water pipe and appurtenances shall be approved by the National Sanitation Foundation (NSF) for potable water pipe.
D. All cast iron fittings and accessories shall be cement lined and conform with ANSI A 21-4 or AWWA C104 "Year of Latest Revision". A bituminous seal coat shall be applied over the cement lining and exterior of the fittings or accessories per A.S.A. Specification A 21-4 "Year of Latest Revision".
E. The average outside diameter shall conform to the following Table:

Nominal Size	Average Outside Diameter (Inches)
4	4.80
6	6.90
8	9.05
10	11.10
12	13.20
14	15.30
16	17.40
18	19.50
20	21.60
24	25.80
30	32.00

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL:

A. All pipe shall be installed in accordance with applicable AWWA Standards.
B. All pipe and fittings shall be placed as shown on the plans and in compliance with the requirements of the specifications.
C. All pipe shall be installed and assembled in accordance with the manufacturer's recommendations.

3.2 INSPECTION OF PIPE:

A. Previous to being lowered into the trench, each pipe and fitting or coupling shall be carefully inspected, and those not meeting the specifications shall be rejected and immediately removed from the project site and replaced with acceptable materials. Such replacement shall be made at no cost to the Owner.
B. Movement of construction equipment and all other vehicles and loads over and adjacent to any pipe shall be done at the Contractor's risk. Any pipe, which in the judgement of the Engineer is damaged or disturbed through any cause, shall be replaced at the expense of the Contractor and at no cost to the Owner.

3.3 PIPE PLACEMENT (GENERAL):

A. Pipe lines shall be placed in the locations and grades as indicated on the Plans and in conformance with this Specification.
B. Trenches shall be kept free from water, and no pipe shall be laid in water.
C. Every effort shall be made to prevent any contamination materials from entering the watermain during storage, construction or repair.
D. Pipe shall be so laid as to be evenly supported throughout the whole length of the barrel, with no weight resting on the bell or coupling. "Bell holes" shall be provided so that bells or couplings of pipe hang free.
E. If the trench is dug deeper than the grade of the barrel, no spalls, shims or lumps shall be used to raise the pipe to the grade, but an even bed shall be formed of sand or accepted fine material properly tamped at no additional expenses to the Owner.
F. In all cases where piping is being installed below the ground surface, before leaving the work for the night or any other time, the end of the pipe shall be securely closed with a water-tight tight-fitting plug, and sufficient backfilling placed to protect the pipe.
G. When pipe is under pressure, and as indicated by the Engineer, reaction or thrust blocks shall be applied on all pipe lines size four (4) inches in diameter or larger at all tees, plugs, caps, and joints deflecting 22-1/2 degrees or more.

3.4 PIPE PLACEMENT (FOUNDATION):

A. All pipe shall be laid on a foundation of compacted Crushed Stone Foundation to the minimum dimensions noted on the detail on the Plans.
B. If in the opinion of the Engineer the subgrade will not properly support the pipe, additional crushed stone material shall be provided as necessary to provide a firm pipe bedding as acceptable to the Engineer.
C. Ground conditions such as quick sand, other soft and yielding or otherwise unsuitable material shall be immediately brought to the Engineer's attention such that evaluation of the necessary bedding can be made.
D. The Contractor is advised that additional crushed stone foundation material shall only be placed where required for the Engineer's acceptance of the work.
E. All Crushed Stone Foundation material shall conform to the requirements of the applicable technical section of the Specifications.

3.5 PIPE PLACEMENT (LOCATION & GRADE):

A. The pipe or invert grade referred to in the specifications and as indicated on the plans is the lowest point of the pipe invert or flow line.
B. Pipe shall be placed in the location and at exactly the lines and grades indicated on the plans.
C. The Engineer shall have the power to require the removal or relaying of any pipe laid contrary to the plans during his absence or that of his assistants or the Project Representative from the project site.
D. Grade or alignment shall not be disturbed by the operation of tamping or backfilling. Care must be taken not to disturb the pipes by stepping on or near them, or by throwing earth on them from the bank or otherwise.

E. The pipes and fittings or couplings shall be so laid in the trench that after the line is completed the interior surface thereof shall conform accurately to the grade and line required by the Engineer, and as indicated on the Plans.

F. Contractor must transfer line and grade to "batter boards" and string line over the trench. The Contractor may not transfer line and grade to and/or utilize a "side line" or string set to line and grade other than over and above the center line of the pipe to be laid.

G. Other methods of Grade and Alignment control are subject to acceptance by the Engineer.

3.6 DISINFECTION:

A. All elements of water line construction installed or disturbed under this contract when complete, shall be disinfected in accordance with these specifications, all applicable requirements of the local, county and state health department and AWWA Standard C651 (latest revision).

B. The method of disinfection shall be in accordance with the methods outlined in the Attachment provided hereto these documents a copy of AWWA Standard for Disinfecting Water Mains C651 except that disinfection in accordance with Section 5.1, TABLET METHOD, is not acceptable.

C. The basic disinfection procedure consists of:

1. Removing, by flushing or any approved method necessary, any materials that may have entered the watermain.
2. Chlorinating any residual contamination that may remain, and flushing the chlorinated water from the main.
3. Protecting the existing distribution system from backflow due to hydrostatic pressure test and disinfection procedures.
4. Determining the bacteriological quality by laboratory test after disinfection.
5. Redisinfection, if necessary.
6. Final connection of the approved new watermain to the active distribution system.

D. When the project includes existing mains which are wholly or partially dewatered, special disinfection procedures in accordance with Subsection 3.9 (hereunder) and the provisions of Section 10 of AWWA C651 shall be utilized.

3.7 TESTING:

A. Sequence of Testing

1. The hydrostatic test and leakage test shall be performed prior to disinfection to preclude the possibility of having to redisinfect if any repairs are necessary.

B. Hydrostatic Test

1. After the water mains have been installed and before pipe joints, fittings, valves or other appurtenances are covered, all of the excess air shall be expelled and the water main shall be pressure tested.
2. Under the pressure test, hydrostatic pressure shall be equivalent to a pressure of 50% above normal operating pressure, based on the elevation of the lowest point on the line or section under test and corrected to the elevation of the test gauge.

3. In no instance shall the pipe lines be tested at a pressure less than 75 psi, nor at a pressure exceeding 175 psi.
4. The pressure test shall be at least two hours in length, preferably before complete backfilling of the pipeline, when the joints are exposed.
5. All visible leaks, any cracked or defective pipe, fittings, valves, or hydrants discovered in consequent of the pressure test shall be removed and replaced by the Contractor with sound material; and the test shall be repeated until results satisfactory to the Engineer are obtained.
6. The Contractor shall furnish all necessary appliances and make the test at his own expense.

C. Leakage Test
1. Leakage test shall be conducted concurrently with the pressure test.
2. Leakage is defined as the quantity of water to be supplied into the newly laid pipe or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
3. The leakage test shall be performed in accordance with AWWA Standard C600 "year of latest revision".
4. Allowable leakage (L) in gph will be determined using the formula:

$$L = \frac{s \times d \times (P)1/2}{148{,}000}$$

Where s = tested length of pipe in feet,
d = the nominal diameter of the pipe in inches,
P = the average test pressure in psi.

5. The test pressure during the leakage test and the duration shall be the same as the hydrostatic test and shall be maintained within 5 psi.
6. The Contractor shall furnish all necessary appliances and make the test at his own expense.

D. Bacteriological Testing -
1. After the piped system has been disinfected and thoroughly flushed, but before the new water lines are final connected to the distribution system or placed in service, the water shall be tested for bacteriological quality and shall show the absence of coliform organisms.
2. Two (2) consecutive sets of acceptable samples, taken at least 24 hours apart shall be collected from the new main. At least one set of samples shall be collected from every 1200 ft. of new watermain, plus one set from the end of the line and at least one set from each branch.
3. Samples shall be collected in sterile containers treated with sodium thiosulfate in accordance with the procedures of the "Standard Methods for the Examination of Water and Wastewater". Samples shall be collected by qualified personnel from sampling taps installed on the main. No hose or fire hydrant shall be used in the collection of samples.
4. Samples shall be tested by a laboratory approved by the New York State

Department of Health for bacteriological testing acceptable to the Engineer. Original signed copies of the results of these tests shall be submitted in writing to the Engineer.

5. All samples shall be tested for bacteriological quality in accordance with "Standard Methods for the Examination of Water and Wastewater", and shall show the absence of coliform organisms. A standard heterotrophic plate count may be required at the option of the Owner and/or Engineer.
6. Sufficient samples shall be collected and tested from the various portions of the system to indicate, to the satisfaction of the Engineer, that a uniform representative sample has been obtained and tested.
7. If samples tested fail to produce satisfactory results, the main shall be reflushed and resampled, and, if necessary, redisinfected as called for in Section 8 of C651 (latest revision).
8. If trench water has entered the new main during construction or, if in the opinion of the Owner and/or Engineer, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately 200 ft and shall be identified by location. Samples shall be taken of water that has stood in the new main for at least 16 hours after final flushing has been completed.
9. The Contractor shall furnish all necessary appliances and make the test at his own expense.

3.8 SPECIAL DISINFECTION PROCEDURES (FOR CUT-INS OR REPAIRS TO EXISTING MAINS):

A. The procedures referenced herein primarily apply to those cases when existing mains are wholly or partially dewatered or, where in the opinion of the Engineer, conditions warrant utilization of these special procedures.

B. When an existing main is opened, either by accident or by design, the excavation will likely be wet and may be badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such pollution. Provisions shall be made to provide such chlorination in these cases.

C. The interior of all pipe and fittings (particularly couplings and sleeves) used in making the repair or installation shall be swabbed or sprayed with a 1 percent hypochlorite solution before they are installed.

D. The Contractor shall utilize thorough flushing as an effective and practical means of removing contamination introduced during repairs. If valve and hydrant locations permit, flushing toward the work location from both directions is recommended. Flushing shall be started as soon as the repairs are completed and shall be continued until discolored water is eliminated. At least 24-hour prior notice shall be made to the Owner and Engineer before any flushing is performed.

E. After the appropriate procedures have been completed, the existing main may be returned to service prior to completion of bacteriological testing in order to minimize the time customers are out of water.

F. Bacteriological samples shall be taken after repairs are completed to provide a record for determining the procedure's effectiveness. If the direction of flow is

unknown, then samples shall be taken on each side of the main break (or cut-in installation). If positive bacteriological samples are recorded, then the situation shall be evaluated with the Engineer and Owner, at which time corrective actions shall be determined and then taken by the Contractor. Daily sampling shall be continued by the Contractor until two consecutive negative samples are recorded.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT:

A. Measurement shall be made on the basis of lineal foot of PVC water pipe of the type and size(s) properly placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include all fittings and/or accessories not specifically included for measurement and payment under other items in the Proposal.

4.2 PAYMENT:

A. Payment will be made at the unit price bid under the appropriate item(s) of the Proposal; the price bid shall include excavation, crushed stone foundation, backfill in a manner acceptable to the Engineer, including all labor, materials, fittings, equipment and appurtenances, testing and other work, as required to complete the work.

END OF SECTION 331113.23

SECTION 331213.15 - TAPPING SLEEVE AND VALVE ASSEMBLY

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Provide and install a tapping sleeve and valve, including valve box(es), at the location indicated on the plans, or as required in the field and accepted by the Engineer.

B. Furnish all material labor, tools and equipment as required to tap the existing main with the required sleeve and valve.

1.2 RELATED WORK:

A. Crushed Stone Foundation – Section 331123

B. Trenching, Backfilling and Compaction - Section 312333

C. Ductile Iron (DI) Water Pipe - Section 331113

D. Polyvinyl Chloride (PVC) Water Pipe and Specials – Section 331113.23

1.3 EXISTING CONDITIONS:

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

B. Contractor shall locate the existing main, and verify conditions in the area shown on the plans for the tap.

PART 2 - MATERIALS

2.1 TAPPING SLEEVE AND VALVE:

A. Sleeve may have caulked or mechanical joint connections to the existing main.

B. Sleeve and valve shall be designed for at least 200 psi working pressure.

C. Valve shall be double disc gate valve, in accordance with AWWA C500 (latest revision).

D. Shall be as manufactured by Clow, Mueller, or approved equal.

2.2 VALVE BOX:

A. Shall be five and one-quarter inch (5 1/4") inside diameter.

B. Shall be two-piece, cast iron, and standard slide type, with cast iron cover.

C. Shall be of proper length for actual trench depth.

D. Cover face shall be lettered "WATER" and have an arrow indicating the direction of opening.

E. Shall be as manufactured by Clow, Mueller, or approved equal.

PART 3 - CONSTRUCTION DETAILS

3.1 CONSTRUCTION DETAILS

A. The tap shall be made without interruption of water service.

B. The completed tap shall be without leakage and any damage to mains shall be repaired by and at the expense of the Contractor.
C. Disinfection procedures shall be followed, in accordance with the specific requirements of this specification, the "Special Disinfection Procedures" subsection of Technical Specification 331113, and per AWWA C651 (Section 10 and 11).
D. Before a tapping sleeve is installed, the exterior of the main to be tapped shall be thoroughly cleaned, and the interior surface of the sleeve shall be lightly dusted with calcium hypochlorite powder.

PART 4 - MEASUREMENT AND PAYMENT

4.1 The cost for all items required for each complete Tapping Sleeve and Valve Assembly, as specified herein, including tapping sleeve and valve, valve box, tie rods, determination of existing conditions, excavation and backfill, crushed stone foundation, use of tapping machine, dewatering and pumping if necessary, testing, disinfection and any and all other work or material required for tapping mains under pressure shall be included in the unit price bid in the Proposal under the appropriate item.

END OF SECTION 331213.15

SECTION 331219 - HYDRANT ASSEMBLIES

PART 1 - GENERAL

1.1 WORK REQUIRED:

A. Furnish and install hydrant assemblies at the locations and depths shown on the Plans and in accordance with these Specifications.

B. Provide necessary thrust blocks and/or tie-rods as required or as shown on the Plans.

1.2 EXISTING CONDITIONS:

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

1.3 SUBMITTALS REQUIRED:

A. The Contractor shall not place any materials until such time that each material used in the work has been accepted by the Engineer.

B. Submittals shall comply with the requirements as delineated in the Contract General Conditions.

PART 2 - MATERIALS

2.1 HYDRANTS:

A. All hydrants provided on any project shall at minimum meet the requirements of the municipality and/or match the current hydrants being installed wherein the work is being performed.

B. Unless otherwise directed by the Owner, the hydrants shall be provided with a main valve opening of 5-1/4", break flange construction, 6" inlet connection, having two(2) 2-1/2" hose nozzles and one(1) 4-1/2" pumper nozzle.

C. Hydrants (unless otherwise noted on the typical detail or directed by the Owner) shall be Centurion A-423 type as manufactured by Mueller Company, or acceptable equal.

D. Hydrants shall open in the same direction as existing hydrants within the municipality.

E. Shall conform to AWWA C502, latest revision.

2.2 AUXILIARY VALVES:

A. Shall be six inches (6") in size.

B. Provide with ends to match connecting pipe.

C. Shall conform to AWWA C500 (latest revision).

D. Unless otherwise directed by the Owner, shall be as manufactured by Clow or acceptable equal.

E. Shall be provided complete with 5-1/4" inside diameter, two-piece, cast iron, standard slide type valve box of proper length for actual trench depth.

F. Cover face for valve box shall be lettered "WATER" and have an arrow indicating direction of opening.

G. Valve boxes shall be as manufactured by Clow or acceptable equal.

2.3 CONNECTING PIPING AND FITTINGS:

A. All connecting piping shall be Ductile Iron and all fittings shall be gray cast iron.

B. Both connecting piping and fittings shall be cement-lined, seal-coated, either push-on or mechanical joint, of the sizes and lengths shown on the Plans.

C. Thrust blocks shall be placed as shown on the Plans, and valves and hydrants shall be tied to the main by means of 3/4" galvanized tie rods, a minimum of two (2) per section, mounted 180° apart.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL:

A. Contractor's attention is directed to the requirements for inspection, marking of rejected specimens, foundation and closing the pipe as found in the specifications for the water pipe being provided as found elsewhere in these documents. These requirements shall be met in the installation of Hydrant Assemblies.

B. Hydrants shall be installed to provide a minimum clear height to nozzle of eighteen (18) inches.

C. Hydrants shall be set and drained in accordance with the applicable detail shown on the Plan Sheet.

D. If groundwater, or evidence thereof, is noted within 2 ft. of the base of the hydrant, same shall immediately be brought to the attention of the Engineer. In such case, the Contractor shall plug the drain hole and the hydrant labeled to instruct the Fire Department to pump out the hydrant after use.

3.2 PAINTING:

A. Hydrants shall be furnished with a shopcoat of yellow paint.

B. Upon completion of the installation, the Contractor shall completely repaint the hydrant, using Koppers Glamortex 501 Enamel, or an acceptable equal. Color to match town Standard.

3.3 TESTING:

A. Testing shall be performed per the requirements as noted under the piping section of these Specifications.

B. All testing shall comply with the applicable standards of the American Water Works Association (AWWA).

3.4 DISINFECTION:

A. Disinfection of the water system will proceed only after completion of hydrant assembly installations.

B. Disinfection shall comply with the requirements as noted under the piping section of these specifications.

C. All disinfection shall comply with the applicable Standards of the American Water Works Association (AWWA).

PART 4 - MEASUREMENT AND PAYMENT

4.1 Unit of measurement shall be for each complete hydrant assembly properly installed.

4.2 Payment will be made based on the price bid per unit in the Proposal; payment will be made for the completed assembly.

4.3 The price bid per unit shall include the costs for the hydrant, valve, valve box, thrust blocks, tie rods, connecting piping, painting and all accessories and appurtenances as required for the complete installation including all labor, equipment and materials as required to complete the work.

END OF SECTION 331219

SECTION 331301 – DISINFECTION TESTING OF PIPELINES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The Contractor shall disinfect all potable and non-potable water pressure pipelines shown on the contract drawings in accordance with ANSI/AWWA C651, latest edition. The Tablet method described in ANSI/AWWA C651 shall not be acceptable. All piping and equipment shall be tested in the field in the presence of the Engineer.

B. Bacteriological samples shall be collected and analyzed on two consecutive days, 24 hours apart from one another. Samples shall be analyzed by an independent laboratory certified by the New York State Department of Health.

C. Chlorination shall not take place until:

1. The main is constructed in accordance with the Contract Documents as modified by the Engineer during construction and all construction permit requirements are met.
2. All blow offs, injection and sample points are constructed and ready for use.
3. The main has been pigged and thoroughly flushed with scouring velocities as needed.
4. The main has been successfully pressure and leakage tested as specified in Division 33.
5. Chlorine neutralization chemicals, and methods for application and disposal of chlorinated water, have been established by the Contractor. The Contractor shall dispose of the water without causing a nuisance or property damage.

1.3 RELATED SECTIONS

A. Related Sections include the following:

1. Division 33 Sections for buried pipe installation requirements.
2. Division 33 Section “Pressure and Leakage Testing of Pipelines” for pressure testing requirements of pipelines.

1.4 SUBMITTALS

A. Prior to Testing: A Disinfection Plan shall be prepared for review and acceptance prior to initiation of work.

1. Disinfection Plan:
2. Type and form of disinfectant proposed.
3. Method and location of disinfectant injection.
4. Test locations.
5. Initial and final disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
6. Flushing locations.
7. Procedure for neutralizing disinfectant and for discharge of flushed water.

8. Proposed testing laboratory name, address and telephone number.

B. For closeout: Disinfection Test Reports performed as well as any laboratory results received as part of this work. Specifically:
   1. Disinfection Report:
      a. Type and form of disinfectant used.
      b. Date and time of disinfectant injection start and time of completion.
      c. Test locations.
      d. Initial and final disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
      e. Date and time of flushing start and completion.
      f. Disinfectant residual after flushing in ppm for each outlet tested.
      g. Procedure for neutralizing disinfectant and for discharge of flushed water.
      h. Signature of person performing tests and signature of witness.
   2. Bacteriological report:
      a. Date issued, project name, and testing laboratory name, address, and telephone number.
      b. Time and date of water sample collection.
      c. Name of person collecting samples.
      d. Test locations.
      e. Initial and final disinfectant residuals in ppm for each outlet tested.
      f. MFT Coliform bacteria test results for each outlet tested. (Other testing methods are not acceptable).
      g. Certification that water conforms, or fails to conform, to bacterial standards of New York State Department of Health.
      h. Certificate: Certify that disinfection testing of water distribution system meets or exceeds requirements of the AWWA.

PART 2 - PRODUCTS

2.1 CHLORINATION CHEMICALS

A. Forms of chlorine to be used for disinfection shall be as listed in AWWA C651 and shall be NSF approved for use with potable water:
   1. Liquid chlorine per ANSI/AWWA B301.
   2. Sodium hypochlorite liquid per ANSI/AWWA B300.

2.2 DECHLORINATION CHEMICALS

A. Chemicals to be used to dechlorinate flushing water shall be as listed AWWA C655, latest edition. Unless superseded by the latest edition acceptable chemicals include but are not limited to:
   1. Sodium Thiosulfate ($Na_2S_2O_3*5H_2O$)
   2. Sodium Bisulfite ($NaHSO_3$)
   3. Sodium Sulfite (Na_2SO_3)
   4. Sulfur Dioxide (SO_2)
   5. Sodium Metabisulfite ($Na_2S_2O_5$)
   6. Calcium Thiosulfate($Ca_2S_2O_3*5H_2O$)
   7. Ascorbic Acid (CH_3COOH)
   8. Sodium Ascorbate ($NaCH_3COO$)

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall locate blow-off valves at low points and dead ends in the grid to permit the removal of sediment.

B. The corporation stops to be used for pressure testing and chlorination shall be installed at the tap valve by the Contractor.

C. Tap for injection of chlorine shall be located to allow for one-way travel through the pipeline to the end point.

D. Source water that is from a public water supply shall use backflow protection. A double check valve assembly or better device approved by the New York State Department of Health is acceptable.

3.2 PRE-TEST FLUSHING

A. All pipelines shall be flushed to remove the lighter solids in the line. Because flushing cannot be relied on to remove heavy material allowed to get into pipeline during installation, every precaution shall be made to protect the pipeline against entrance of foreign material during the installation process.

B. Every new pipeline shall be flushed at a minimum velocity of 3.0 feet per second (fps) to ensure that the lighter solids are removed from the pipe interior. (Note that it may be difficult to obtain scouring velocities in a pipe over two hundred (200) feet in length.) Where instances of velocity cannot be ascertained easily, Contractor and Engineer shall agree on when sufficient flushing has occurred.

C. Discharge velocity can be determined by a simple field procedure involving the "trajectory" method. For any size pipe discharging horizontally three feet above the ground, a stream of water traveling at twelve (12) feet per second will strike the ground six feet away. Similarly, a stream of water traveling at five feet per second will strike the ground more than two feet from the end of the pipe. This test must be made thru an open-ended pipe; it must not end with a valve or fitting, which would be smaller than the inside diameter of the pipe.

D. All pipelines eight inches in diameter or greater, or pipelines suspected of having heavy foreign material in them, shall be subjected to open end flushing to remove any foreign material from the pipeline. Pigging is required in addition to open-end flushing.

E. A velocity of 5.0 fps is desirable and a velocity of 12 fps may be needed to remove sand from river undercrossings and other subsurface inverts if applicable to the water main route or known deposits.

F. Table 1, provided at the end of this Specification, outlines the number and size of flushing assemblies required.

G. During the flushing process, a clean white cup shall be used at all sampling points to visually check for water clarity. When all the sample points are clear, meaning there is no background sediment, and the system chloramines residual is present, the line is ready to schedule for chlorination.

H. In the case of mains twenty-four (24) inch and larger, preliminary flushing may be replaced by stringent measures for removal of dirt and sediment from the pipe and the thorough cleaning of its interior prior to filling with the high chlorine solution. Swabbing with a chlorine solution may be required at the discretion of the Engineer. Confined space procedures shall be followed if personnel enter the pipe to perform work.

3.3 CHLORINATION

A. Upon satisfactory completion of all testing and flushing, the Contractor shall furnish all materials and labor necessary to disinfect all water mains in accordance with the applicable sections of AWWA C-651, latest edition.

B. Prior to chlorine injection the following shall be ensured:
   1. That the source water tap valve for the water mains to be chlorinated has been shut off.
   2. That all blow offs and sample points involved in the Project are open
   3. That there are no open valves to activate water mains tied into the water mains to be chlorinated.
   4. That there is an uninterrupted supply of potable water or adequate number of barrels to assure there is no interruption once the injection process begins.

C. Disinfection of water mains shall be completed in accordance with ANSI/AWWA C651, latest edition standards and shall include the following; preflushing or cleaning of the water mains before the application of chlorine, disinfecting the mains with the prescribed chlorine dose for the disinfection method being utilized, allow for the proper amount of chlorine holding or contact time, ensuring that the applicable chlorine residual was maintained for the duration of the disinfection period, and final flushing and clearing of the heavily chlorinated water with the disposal and treatment of the heavily chlorinated water in accordance with applicable dechlorination methods.

D. All sampling points shall be at sites as designated by the approved plan.

E. Satisfactory bacteriological analysis shall be determined by the results of samples collected by the Contractor and analyzed at a New York State certified lab as required by the Department of Health.

F. The Town shall furnish the Contractor with sufficient water to perform the disinfection required. As the chlorine solution is being injected the chlorine residual at the closest sample point to the injection point shall be tested with a high Cl2 test kit or DPD reagent as applicable. The water flow or solution strength shall be adjusted as necessary to achieve the recommended minimum chlorine strength.

G. As the high chlorine solution reaches each successive sample point, the valve at the sample point shall be closed. Prior to closing the valve at the last sample point, the following water main shut down process shall take place in sequence:
   1. The source water control valve shall be closed.
   2. The injection pump should be shut off and its valve closed.
   3. The last blow off/ sample point valve should be closed.

   ALL BLOW-OFF VALVES SHALL NEVER BE CLOSED BEFORE THE SOURCE WATER VALVE IS CLOSED.

H. The initial chlorine solution shall be no less than 50 ppm and not more than 1000 ppm in concentration and shall be left standing in the main for a period of not less than twenty-four (24) hours and not more than forty-eight (48) hours. There must be a chlorine residual of 10 ppm at the sample point after twenty-four (24) hours. After this period, the high chlorine water shall be drained and/or flushed from the system.

3.4 POST TEST FLUSHING

A. Draining and/or flushing the solution from the main shall be the responsibility of the Contractor and shall be performed so as not to cause damage to the environment or create a nuisance to property or environment. The Contractor shall inform the Engineer of the proposed methods of disposal of the high chlorine solution.

B. Where applicable flushed water shall be treated to remove the chlorine residual from the water being discharged that has the potential to impact storm sewer, retention pond, lake, bay, or any other body of water, chemicals for dechlorinating the water shall be as specified above. See AWWA Standard C655, for additional details. This process shall be followed each time water is discharged. The following doses are for reference only. Their use does not release the Contractor from the responsibility of achieving full dechlorination. Manufacturer's suggested dose shall supersede the below values.

De-Chlorination Chemical	Dose in Parts (mg) required per part (mg) Chlorine at pH 8.0
Sodium Thiosulfate (Na2S2O3*5H2O)	1.86
Sodium Bisulfite (NaHSO3)	1.61
Sodium Sulfite (Na2SO3)	1.96
Sulfur Dioxide (SO2)	0.9
Sodium Metabisulfite (Na2S2O5)	1.47
Calcium Thiosulfate(Ca2S2O3*5H2O)	1.19
Ascorbic Acid (CH3COOH)	2.48
Sodium Ascorbate (NaCH3COO)	2.78

3.5 SAMPLING

A. The Contractor shall schedule bacteriological sampling through the state certified lab. The Engineer shall be present during all sampling times.

B. Before the water samples are collected, the Contractor shall ensure that all the blow off(s) and sample point(s) are opened and that the source water control valve is open.

C. Bacteriological sampling shall be conducted in accordance with New York State Department of Health regulations. Disinfection residuals shall be measured and recorded. Bacteriological samples shall be collected and analyzed on two or more consecutive business days each taken twenty-four (24) hours apart.

D. Prior to initiating sampling, a check for the Free Chlorine Residual at the last sample point is recommended to confirm that the residual is representative of the incoming source water.

E. If the Free Chlorine Residuals are satisfactory, the specialist will begin water sample collection.

F. After the sampling is completed, the Contractor shall initiate the shut down process using the following sequence:
   1. Turn off blow off(s) and sample point(s).
   2. Shut off the control valve.

G. Main Clearance Sampling is completed when each sample site has two consecutive day satisfactory (Total Coliform Absent) results.

H. Bacteriological test results for new and altered public drinking water mains will be considered invalid if the pressure in the mains is not maintained at 20 psi or greater after the samples are collected.

I. Flushing and sampling shall be repeated, as required, if total coliform is detected in a water sample. If necessary, the main shall be re-chlorinated.

3.6 ACTIVATION

A. No section of any main shall be put into service without the written permission of the Engineer and/or Department of Health.

B. The water main(s) needs to be thoroughly flushed before it is actually placed into service using potable water.

C. To achieve this flushing, fire hydrants may be utilized on 6-inch and larger water mains. On water mains less than 6-inches, a permanent blow-off may be used if provided. Otherwise the temporary blow-offs setup for the flushing, chlorination and main clearance sampling procedures must be utilized.

D. Before activation, new water mains should be flushed until the water runs clean and clear. In addition, after the water main has been flushed, field tests for Total Chlorine should be taken to ensure disinfection residuals are similar to and representative of the source water. Notify the Engineer of any discrepancies.

E. If a water main tie-in is involved or if the pressure in the main was not maintained at 20 psi or greater, notify the Engineer and water samples for bacteriological analysis should be collected.

TABLE 1

(For Information Purposes Only, Nozzles based on 40 psi Residual Pressure)

Pipe Size (NPS)	Flow (gpm) Required for 3.0 fps	Number of Hydrant Outlet Nozzles	Size (in.) of Hydrant Nozzles
4	120	1	2.5
6	260	1	2.5
8	270	1	2.5
10	730	1	2.5
12	1,060	2	2.5
14	1,440	2	2.5
16	1,880	2	2.5
18	2,380	1	4.5
20	2,940	1	4.5
24	4,240	2	4.5

TABLE 2

(For Information Purposes Only, Chlorine Required to produce an initial 25 mg/L concentration in 100 ft of pipe)

Pipe Size (NPS)	100% Chlorine (lbs)	1% Hypochlorite Solution (gal)
4	0.013	0.16
6	0.03	0.36
8	0.054	0.65
10	0.085	1.02
12	0.12	1.44
16	0.217	2.60

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement shall be made on the basis of lineal foot of pipe of the type and size(s) properly placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include all fittings and/or accessories not specifically included for measurement and payment under other items in the Proposal.

4.2 PAYMENT

A. Payment will be made at the unit price bid under the appropriate item(s) of the Proposal.

END OF SECTION 331301

SECTION 334100 – HIGH DENSITY POLYETHYLENE DRAINAGE PIPE
(Double-Wall Corrugated)

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. Furnish and install corrugated double-wall high density polyethylene drainage pipe of the size(s) shown on the Plans and in the Proposal.

1.2 RELATED WORK:

A. Crushed Stone Foundation - Section 312323.13.01
B. Trenching, Backfilling and Compaction - Section 312333

1.3 EXISTING CONDITIONS:

A. It shall be the Contractor's responsibility to investigate all site conditions that may affect his work.

PART 2 - MATERIALS

2.1 GENERAL:

A. All drainage pipe to be installed shall be Type N-12 as manufactured by Advanced Drainage Systems, Inc. (ADS), or acceptable equal per AASHTO.

B. Pipe Requirements
   1. 4 through 10-inch (100 to 250mm) pipe shall meet AASHTO M252, Type S
   2. 12 through 60-inch (300 to 1500 mm) pipe shall meet AASHTO M294, Type S or ASTM F2306
   3. Manning’s “n” value for use in design shall be 0.012

C. Fitting Requirements
   1. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a welded bell and valley or saddle gasket meeting the watertight join performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

D. Material Properties
   1. Material of pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4 through 10-inch (100 to 250 mm) diameters, and 435400C for 12 through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350. Except that carbon black content should not exceed 4%. The 12 through 60-inch pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 5.1 and 9.5 of AASHTO M294 and ASTM F2306 respectively.

PART 3 - CONSTRUCTION DETAILS

3.1 GENERAL:

A. All pipe shall be handled and assembled in accordance with the manufacturer's instructions, except as modified herein or on the Plans.
B. Piping shall be set at the elevations and locations as shown on the Plans.
C. Installation shall conform to the requirements of the details as shown on the Plans.
D. Installation shall be in accordance with ASTM D2321 and ADS recommended installation guidelines, with the exception that minimum cover in trafficked areas for 4 through 48 inch (100 to 1200 mm) diameters shall be one foot and for 60-inch diameter the minimum cover shall be 2 feet in single run applications.

3.2 JOINTS:

A. Pipe shall be joined using a bell and spigot join meeting the requirements of AASHTO M252, AASHTO M294, or ASTM F2306.
B. The joint shall be watertight according to the requirement of ASTM D3213.
C. Gaskets shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris.
D. A joint lubricant available from the manufacturer shall be sued on the gasket and bell during assembly. 12 through 60-inch diameter shall have an exterior bell wrap installed by the manufacturer.

3.3 FIELD PIPE AND JOINT PERFORMANCE:

A. To assure watertightness, filed performance verification may be accomplished by testing in accordance with ASTM F2487. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

3.4 DAMAGES TO MATERIALS:

A. Movement of construction equipment and all other vehicles and loads over and adjacent to any pipe shall be done at the Contractor's risk. Any pipe, which in the judgement of the Engineer is damaged or disturbed through any cause, shall be replaced at the expense of the Contractor and at no cost to the Owner.
B. Any pipe or materials designated by the Engineer as defective or damaged shall be immediately removed from the project site and replaced with acceptable materials. Such replacement shall be made at no cost to the Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT:

A. Measurement will be made based on the total linear foot of pipe, type and size placed, as measured by the Engineer. Measurements shall be made horizontally along the axis of the pipe and shall include the run through all fittings and/or manholes and catch basins.

4.2 PAYMENT:

A. Payment will be made at the unit price bid under the appropriate item(s) of the Proposal; the price bid shall include excavation, removal of any existing piping shown to be removed, pipe and fittings, end sections, crushed stone foundation (as required by the details), backfill in a manner acceptable to the Engineer, restoration, including all labor, materials, equipment and appurtenances as required to complete the work.

END OF SECTION 334100