PROJECT MANUAL / SPECIFICATIONS

VOLUME 3 OF 3
DIVISIONS 21 - 33

ENLARGED CITY SCHOOL DISTRICT OF MIDDLETOWN
223 Wisner Road, Middletown, NY 10940

TWIN TOWERS MIDDLE SCHOOL ADDITIONS AND ALTERATIONS

NYSED Project Control No. 44-10-00-01-0-001-041

ARCHITECT KG+D ARCHITECTS, PC

285 Main Street, Mount Kisco, NY 10549

CIVIL ENGINEER	**INSITE ENGINEERING, SURVEYING & LANDSCAPE ARCHITECTURE, PC** 3 Garrett Place, Carmel, NY 10512
LANDSCAPE ARCHITECT	**THE LA GROUP LANDSCAPE ARCHITECTURE & ENGINEERING, PC** 179 Graham Road, Ithaca, NY 14850
STRUCTURAL ENGINEER	**THE DI SALVO ENGINEERING GROUP** Lee Farm Corporate Park, Suite 200 83 Wooster Heights Road, Danbury, CT 06810
ROOFING CONSULTANT	**WATSKY ASSOCIATES** 20 Madison Avenue, Valhalla, NY 10595
FACADE RESTORATION CONSULTANT	**RYAN BIGGS CLARK DAVIS ENGINEERING & SURVEYING, DPC** 257 Ushers Road, Clifton Park, NY 12065
SYSTEMS ENGINEER	**GERARD ASSOCIATES CONSULTING ENGINEERS, DPC** 223 Main Street, Goshen, NY 10924
LIGHTING CONSULTANT	**GOLDSTICK LIGHTING DESIGN, LTD** 828 South Broadway, Tarrytown, NY 10591
SPECIFICATIONS CONSULTANT	**SUE MCCLYMONDS, AIA** 200 Robb Road, Amsterdam, NY 12010
FOOD SERVICE CONSULTANT	**RAYMOND RAYMOND ASSOCIATES** 44 St. John Street, Goshen, NY 10924
ABATEMENT DESIGNER	**ADELAIDE ENVIRONMENTAL HEALTH ASSOCIATES** 1511 Route 22, Suite C24, Brewster, NY 10509

BID ISSUE: DECEMBER 14, 2023

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.

_____

Walter Hauser, AIA

TABLE OF CONTENTS

VOLUME 1

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 24 - 25 – not used

DIVISION 26 – ELECTRICAL

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. 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. Rotor: Random-wound, squirrel cage.
5. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating.
7. Insulation: Class F.
8. 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.
9. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

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.

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, 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, 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.
   2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for vibration isolation devices and seismic restraints.

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.
3. Design seismic-restraint hangers and supports for piping and equipment.

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 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.
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 AND SEISMIC 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. Designated Seismic System: A fire-suppression 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 (for the 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. 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.
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 Submittal:
   1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint

accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraint Selection: Select seismic restraints 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, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.
e. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Seismic-Restraint Detail Drawing:
   a. Design Analysis: To support selection and arrangement of seismic 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.
3. Product Listing, Preapproval, and Evaluation Documentation: By UL, FM Approvals, OSHPD, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated design submittals for seismic-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

D. 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. Coordination Drawings: Show coordination of seismic bracing for fire-suppression 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. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active fire-suppression system seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or experience data as permitted by ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

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. Seismic 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: UL product listing and FM Approvals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic control system.
   1. Seismic Performance: Equipment must be designed and secured to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7-16.
B. Seismic Design Calculations:
   1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in NFPA 13 and 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 the edition intended as reference throughout the Section Text.
      a. Data indicated below to be determined by Delegated Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
      b. Building Risk Category: III.
      c. Building Site Classification: E.
   2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

a. Horizontal Seismic Design Force Fp: Value is to be calculated by Delegated Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:
   1) S_{DS} = Spectral Acceleration: 0.208g. Value applies to all components on Project.
   2) a_p = Component Amplification Factor: See Drawing Schedule for each component.
   3) I_p = Component Importance Factor: 1.5.
   4) W_p = Component Operating Weight: For each component. Obtain by Delegated Design Contractor from each component submittal.
   5) R_p = Component Response Modification Factor: See Drawing Schedule for each component.
   6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated Design Contractor. For items at or below the base, "z" is to be taken as zero.
   7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated Design Contractor.
b. Vertical Seismic Design Force: Calculated by Delegated Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
c. Seismic Relative Displacement D_{pl}: Calculated by Delegated Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:
   1) Dp = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
   2) Ie = Structure Importance Factor: 1.25. Value applies to all components on Project.

C. Consequential Damage: Provide additional seismic and wind-load restraints for suspended fire-suppression system components or anchorage of floor-, roof-, or wall-mounted fire-suppression system components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential fire-suppression system component will not cause the failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. 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. Seismic-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.

3.3 INSTALLATION OF VIBRATION CONTROL, WIND-LOAD-RESTRAINT, AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Fire-Suppression Vibration Isolation, Seismic, and Wind-Load-Restraint Schedule, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraintdevices for systems and equipment where indicated in Equipment Schedules or Vibration Isolation, Seismic, and Wind-Load-Restraint Schedules, where indicated on Drawings, where the 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 and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with installation requirements of NFPA 13 for installation of all seismic-restraint devices.

F. 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.
   3. Install seismic-restraint devices using methods approved by OSHPD that provides required submittals for component.

G. 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.

H. Install seismic-restraint devices using methods approved by OSHPD that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. 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.

K. 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.

L. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross structural seismic joints and other points where differential movement may occur, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211000 "Water-Based Fire-Suppression Systems" for piping flexible connections.

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.

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. 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.

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.

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.

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. Hose connections and hose stations.
4. Fire-suppression piping specialties.
5. Sprinklers.
6. Alarm devices.
7. 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 and NFPA 14 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. Seismic Qualification Certificates: For fire-suppression equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Qualification Data: For qualified Installer and professional engineer.

D. Design Data: Approved fire-suppression piping working plans, prepared in accordance with NFPA 13 and NFPA 14, including documented approval by AHJs, and including hydraulic calculations if applicable.

E. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. 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.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Automatic wet-type, Class I standpipe system.
B. Automatic combination wet-type standpipe sprinkler system.
C. Automatic wet-pipe sprinkler system.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire-suppression system piping to withstand the effects of earthquake motions determined in accordance with NFPA 13 NFPA 14 and ASCE/SEI 7. See Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
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. Standard-Pressure Piping System Component: Listed for 175 psig minimum working
D. 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.

E. 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.

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 & STANDPIPE".
14. Finish: Polished chrome plated.
15. Outlet Size: NPS 4.

2.5 HOSE CONNECTIONS AND HOSE STATIONS

A. Hose Connections, Nonadjustable 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. 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 668.
3. Description: Fire hose valve for connecting fire hose.
4. Pressure Rating: 300 psig minimum.
5. Material: Brass or bronze.
6. Size: NPS 2-1/2, as indicated.
7. Inlet: Female pipe threads.
8. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
9. Pattern: Angle.
10. Finish: Rough brass or bronze.

2.6 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.

2.7 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, Standard Response:
a. Pendent.
b. Recessed pendent.

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.

2.8 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.

2.9 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 and NFPA 14.
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 WATER-SERVICE PIPING

A. Comply with requirements for fire-suppression water-service piping in Section 331415 "Site Water Distribution Piping."

3.3 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 and NFPA 14 requirements for installation of fire-suppression piping.

C. Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.

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

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

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

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

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

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

J. Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to exterior of building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for fire-suppression piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. 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.

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

O. 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."

P. 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."

Q. 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."

3.4 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. Extruded-Tee Connections: Form tee in copper tube in accordance with ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 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.

3.6 INSTALLATION OF HOSE CONNECTIONS AND HOSE STATIONS

A. Examine roughing-in for hose connections and hose stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, and other conditions where hose connections and hose stations are to be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.
D. Indicate hose-connection and hose-station locations, sizes, and special devices on Drawings.
E. Install hose connections adjacent to standpipes.
F. Install freestanding hose connections and hose stations for access and minimum passage restriction.
G. Install NPS 1-1/2 hose-connection and hose-station valves with flow-restricting device unless otherwise indicated.
H. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device unless otherwise indicated.
I. Install freestanding hose stations with support or bracket attached to standpipe.
J. Install hose-reel hose stations on wall with bracket.

3.7 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.

3.8 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.

3.9 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."

3.10 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.

3.11 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.

3.12 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.

3.13 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
C. 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.
D. 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.

E. 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.

3.14 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 213113 - ELECTRIC-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. In-line fire pumps.
   2. Fire-pump accessories and specialties.
   3. Grout.

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 fire pumps, motor drivers, and fire-pump accessories and specialties.
   1. Include plans, elevations, sections, and mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

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

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 20.

B. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Component Importance Factor: 1.5.
C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.
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.

2.2 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.

2.3 IN-LINE 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. A-C Fire Pump; a Xylem brand.
   2. Patterson Pump Company; a Gorman-Rupp company.
   3. Peerless Pump Company.
   4. Pentair Aurora; Pentair Pump Group.
   5. S.A. Armstrong Limited.
B. Pump:
   1. Standard: UL 448, for in-line pumps for fire service.
   2. Casing: Radially split case, cast iron, with ASME B16.1 pipe-flange connections.
   3. Impeller: 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 shaft is vertical, with motor above pump and pump on base. Motor and pump rotating assembly shall be removable from top without removing the pump casing from the piping.
C. Coupling: None or rigid.
D. Driver:
   1. Standard: UL 1004A.
   2. Type: Electric motor; NEMA MG 1, polyphase Design B.
E. Capacities and Characteristics:
   1. Rated Capacity: 1000 gpm.
   2. Total Rated Head: 120 psig.
   3. Inlet Flange: Class 125.

4. Outlet Flange: Class 125.
5. Motor Horsepower: 125 hp.
6. Motor Speed: 3500 rpm.
7. Electrical Characteristics:
   a. Volts: 480 V.
   b. Phase: Three.
   c. Hertz: 60.
   d. Full-Load Amperes: 156 A.

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Pipe sizes for pump test header, relief valves, discharge cones, and number and size of manifold hose valves are set by NFPA 20, so are not required in this article.

B. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

C. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

D. 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.
      c. Kunkle Valve.
      d. WATTS; A Watts Water Technologies Company.
      e. Zurn Industries, LLC.
   2. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

E. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

F. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

G. Discharge Cone: Closed type.

H. Hose Valve Manifold Assembly:
   1. Standard: Comply with requirements in NFPA 20.
   2. Header Pipe: ASTM A53/A53M, 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: UL 1726.
   5. Manifold, Flush-Type Body:
      a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
      b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
      c. Nipples: ASTM A53/A53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.
      d. Escutcheon Plate: Brass or bronze; rectangular.
      e. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
      f. Exposed Parts Finish: Polished, chrome plated.
      g. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.5 GROUT

A. Standard: ASTM C1107, 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.

2.6 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 for installation tolerances, and other 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 bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic 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. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
I. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. 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.
B. Align piping connections.
C. 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 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 electric-motor-driver fire-pump controllers specified in Section 262933 "Controllers for Fire-Pump Drivers."
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
    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.
D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
E. Prepare test and inspection reports.

F. 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 213113

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.

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. Total Dynamic Head: 300 feet.
3. Working Pressure: 175 psig minimum.
4. Discharge and Suction Flanges: Class 250.
5. Motor Horsepower: 2.
6. Motor Speed: 3450 rpm.
7. Electrical Characteristics:
   a. Volts: 480.
   b. Phases: Three.
   c. Hertz: 60.
   d. Full-Load Amperes: 3.4.

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 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.

3.3 ADJUSTING

A. Lubricate pumps as recommended by manufacturer.
B. Set field-adjustable pressure-switch ranges as indicated.

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.

PART 2 - PRODUCTS

2.1 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.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

2.6 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.

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 (DN 50) and Smaller: Bronze, swing check valves with nonmetallic disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron, swing check valves with lever and weight or spring.
      c. NPS 2-1/2 (DN 65) 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 (DN 50) and Smaller: Threaded, soldered, or press-end connections.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 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 (DN 50) 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 (DN 65) 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 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
      b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
      c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
      d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
      e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.
   5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
   6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 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.

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.
   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 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 099100 "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:
    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.

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 and associated pumps and controls.
   2. Elevator sump pump system and associated 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 - domestic water.
   3. Piping joining materials - domestic water.
   4. Transition fittings - domestic water.
   5. Dielectric fittings - domestic water.

B. Related Requirements:
   1. Section 331415 "Site Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Copper tube and fittings - domestic water.
   2. Ductile-iron pipe and fittings - domestic water.
   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, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger is to be the following:
   1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

D. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) is to be the following:
   1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern, mechanical-joint fittings; and mechanical joints.

E. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller is to be the following:
   1. Drawn-temper annealed-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 (DN 50) 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.

G. 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.

H. 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 EARTHWORK

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

3.3 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 and packaged booster 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."

3.4 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. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on joint fittings by inserting tube to measured depth.

H. 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.

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

3.5 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 (DN 40) and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits, nipples.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

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

C. 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.

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

E. 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.

3.8 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. 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.

3.9 IDENTIFICATION

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

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system 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.

3.11 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.

3.12 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. Outlet boxes.
   7. Hose bibbs.
   8. Wall hydrants.
   9. Drain valves.
   10. Water-hammer arresters.
   11. Flexible connectors.
   12. Water meters.

B. Related Requirements:
   1. Section 220500 "Common Work Results for Plumbing."
   2. Section 221116 "Domestic Water Piping" for water meters.
   3. Section 224716 "Pressure Water Coolers" for water filters for water coolers.

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. Laboratory-Faucet 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 1035.
3. Size: NPS 1/4 or NPS 3/8 matching faucet size.
4. Body: Bronze.
5. End Connections: Threaded.
6. Finish: Chrome plated.

E. 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. Reduced-Pressure-Principle Backflow Preventers:
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 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 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.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention 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. 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.

C. Beverage-Dispensing-Equipment Backflow Preventers:
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 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel or non-metallic.
6. End Connections: Threaded or flare.

D. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. WATTS; A Watts Water Technologies Company.
2. Standard: ASSE 1032.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8.
5. Body: Stainless steel.

6. End Connections: Threaded or flare.

E. 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 OUTLET BOXES

A. Icemaker Outlet Boxes:

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. Guy Gray, IPS Corporation.
   b. Oatey Co.
   c. Sioux Chief Manufacturing Company, Inc.
2. Mounting: Recessed. Fire rated (where required, coordinate with architectural drawings).
3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.9 HOSE BIBBS

A. Hose Bibbs:

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.

2.10 WALL HYDRANTS

A. Lead Free Nonfreeze Wall Hydrants:
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.

2.11 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.

2.12 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.

2.13 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.

2.14 WATER METERS

A. Turbine-Type Water Meters:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Badger Meter.
      b. Carlon Meter.
      c. Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.
      d. Neptune Technology Group Inc.

e. Niagara Meters.
2. Standard: AWWA C701.
3. Pressure Rating: 150 psig working pressure.
4. Body Design: Turbine; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.
   a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
      1) System to be capable of transmitting data using AMR/AMI technology.
6. Case: Bronze or Epoxy-coated cast iron.
7. End Connections: Threaded or flanged.

B. Compound-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Badger Meter.
   b. Mueller Systems, LLC; a subsidiary of Mueller Water Products, Inc.
   c. Neptune Technology Group Inc.
   d. Sensus; a Xylem brand.
2. Standard: AWWA C702.
3. Pressure Rating: 150-psig working pressure.
4. Body Design: With integral mainline and bypass meters; totalization meter.
5. Registration: In gallons or cubic feet as required by utility company.
   a. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
      1) System to be capable of transmitting data using AMR/AMI technology.
6. Case: Bronze or Coated ductile iron.
7. End Connections: Flanged.

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. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061053 "Miscellaneous Rough Carpentry."
F. 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.

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.

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

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.

B. Related Requirements:
   1. Section 226600 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

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 (DN 50) and Smaller: Use dielectric nipples or unions.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits, or nipples.
   4. Dielectric Fittings for NPS 5 (DN 125) 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. (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Ft. (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   5. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) 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.
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 (DN 100) 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 (DN 125) 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 (DN 100) 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 (DN 125) 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 (DN 100) 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 (DN 125) 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 (DN 300).
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 221323 "Sanitary Waste Interceptors" for metal and concrete interceptors outside the building, grease interceptors, grease-removal devices, oil interceptors, and solids interceptors.
   2. 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.
   2. Floor sinks.
   3. Trench drains.
   4. Channel drainage systems.

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:
   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.

2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:
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. WATTS; A Watts Water Technologies Company.
c. Wade; a subsidiary of McWane Inc.
d. Zurn Industries, LLC.
e. Josam Company.
2. Standard: ASME A112.6.7.
3. Pattern: Floor or Funnel floor drain, refer to schedule on drawings.
4. Body Material: Cast iron.
5. Anchor Flange: Required, with seepage holes.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Sediment Bucket: Required.
10. Internal Strainer: Not required.
11. Internal Strainer Material: Not required.
12. Top Grate Material: Cast iron, loose, hinged.
13. Top of Body and Grate Finish: Nickel bronze or Acid-resistant enamel.
14. Top Shape: Square.
15. Dimensions of Top Grate: Refer to schedule on drawings .
16. Top Loading Classification: No traffic.
17. Funnel: Required..

2.4 TRENCH DRAINS

A. Trench Drains:
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 for trench drains.
3. Material: Ductile or gray iron.
4. Flange: Anchor.
5. Clamping Device: Required.
6. Outlet: Bottom.
7. Grate Material: Ductile iron or gray iron or Stainless steel.
8. Grate Finish: Not required.
9. Dimensions of Frame and Grate: Refer to schedule on drawings.
10. Top Loading Classification: Heavy Duty.

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. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

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

3.3 LABELING AND IDENTIFYING

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

3.4 PROTECTION

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

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

END OF SECTION 221319.13

SECTION 221323 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Solids interceptors.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.
B. PP: Polypropylene.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Piping connections. Include size, location, and elevation of each.
   2. Interface with underground structures and utility services.

1.6 CLOSEOUT SUBMITTALS

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

1.7 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
   1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of service.
   2. Do not proceed with interruption of sewer services without Construction Manager's or Owner's written permission.

PART 2 - PRODUCTS

2.1 SOLIDS INTERCEPTORS

A. Cast-Iron or Steel Solids Interceptors:

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. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: Cast iron or steel.
4. Interior Separation Device: Screens.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Not required Insert coating.
7. Mounting: Above floor.

B. Plastic Solids Interceptors:
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. MIFAB, Inc.
   b. Xerxes by Shawcor Ltd.
   c. Zurn Industries, LLC.
2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: Plastic.
4. Interior Separation Device: Screens.
5. Mounting: Above floor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set interceptors level and plumb.
B. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet.
1. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

3.2 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Make piping connections between interceptors and piping systems.

3.3 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.
B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 221323

SECTION 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. Galvanized-steel pipe and fittings.
   4. Specialty pipe fittings.

B. Related Requirements:
   1. Section 221429 "Sump Pumps" for storm drainage pumps.

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. Galvanized-steel pipe and fittings.
   4. 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. Storm Drainage, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

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

2.3 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 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A53/A53M, Type E, standard-weight class. Include ends matching joining method.
   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. U.S. Steel.
      b. Wheatland Tube; Zekelman Industries.

B. Steel-Pipe Pressure Fittings:
   1. Steel Pipe Nipples: Galvanized, ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   3. Gray-Iron, Threaded Fittings: Galvanized, ASME B16.4, Class 125, standard pattern.

C. Cast-Iron Flanges: ASME B16.1, Class 125.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.6 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.
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.
K. 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.
L. 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.
M. 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.

N. Install steel piping in accordance with applicable plumbing code.

O. Install force mains at elevations indicated.

P. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping.
   a. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."
2. 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."
3. Install drains in storm drainage gravity-flow piping.
   a. Comply with requirements for drains specified in Section 221423 "Storm Drainage Piping Specialties."

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

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

1. 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.

1. 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.

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.
3. In Aboveground Force-Main Piping: Fitting-type 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 (DN 50) and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges, flange kits, or nipples.
4. Dielectric Fittings for NPS 5 (DN 125) 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. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.
D. 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 (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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 galvanized-steel 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.

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.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.
   a. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.
   a. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 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.

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 is to be the following:
   1. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 is to be the following:
   1. Galvanized-steel pipe, pressure fittings, and threaded joints.
   2. Fitting-type transition couplings if dissimilar pipe materials.

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. Section 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: .
      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. Cast-Iron Parapet Roof Drains:
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.
b. Standard: ASME A112.6.4.
c. Body Material: Cast iron.
d. Grate Material: Nickel-bronze alloy.
e. Outlet: Back.
f. Outlet Type: No-hub.
g. Options:
1) Vandal-proof grate.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles:
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.

B. Plastic, Horizontal Backwater Valves:
   1. Plastic, 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) IPS Corporation.
         2) Oatey Co.

3) RectorSeal Plumbing; A CSW Industrials Company.
4) Sioux Chief Manufacturing Company, Inc.
5) Spears Manufacturing
6) Zurn Industries, LLC.

b. Standard: ASME A112.14.1.
c. Size: Same as connected piping.
d. Body Material: PVC.
e. Cover: Same material as body with threaded access to check valve.
f. Check Valve: Removable swing check.
g. End Connections: Socket type.

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 221429 - SUMP 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. Oil-sensing sump pumps and controllers.

1.3 ACTION SUBMITTALS

A. Product Data:
   1. Oil-sensing sump pumps and controllers.
B. Product Data Submittals: For each product.
   1. Construction details, material descriptions, dimensions of individual components and profiles.
   2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
C. 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 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 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls.
   1. Indicate actual installed items by marking submittals with an arrow or box.

1.5 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 manufacturer's written instructions for handling.

1.6 WARRANTY

A. Manufacturer Warranty: Manufacturer and Installer agree to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Faulty operation of pump and associated controls.
      b. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of sump pump from single source from single manufacturer.

2.2 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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

2.3 OIL-SENSING SUMP PUMPS AND CONTROLLERS

A. Oil-Sensing Sump Pumps and Controllers: P-18.
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. Industrial Flow Solutions.
b. Liberty Pumps.
c. Little Giant; a brand of Franklin Electric Co., Inc.
d. Weil Pump; a Wilo Company.
e. Zoeller Company.
2. Description: Factory-assembled and -tested sump-pump unit. ASME A17.1 compliant.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 14.1-14.2 and HI 14.3.
4. Pump Casing: Cast iron, with strainer inlet; legs that elevate pump to permit flow into impeller; and vertical discharge for piping connection.
5. Capacities and Characteristic:
a. Unit Capacity: 74 gpm.
b. Number of Pumps: One.
c. Each Pump:
1) Capacity: 74.
2) Total Dynamic Head: 37.
3) Discharge Size: 2 NPS.
4) Electrical Characteristics:
a) Motor Horsepower: 1/2 hp.
b) Volts: 115 V ac.
c) Phases: Single.
d) Hertz: 60.
d. Unit Electrical Characteristics:
1) Full-Load Amperes: 8 A.
6. Controls:
a. Industrial-grade switch(es) with internal 20 A relay and Type 304 stainless steel sensor probes.
b. Liquid/oil sensor that differentiates and indicates the presence of oil and/or water under high-water conditions.
c. Alarm Panel:
1) High-oil-level alarm.

2) High-water-level alarm.
3) Audible and visual alarms for each alarm condition.
4) Dry contacts for remote monitoring of oil, water, and high liquid conditions.

d. Control Panel:
1) Simplex.
2) Enclosure: NEMA 250, Type 4X.
3) HOA switch(es).
4) Green pump run light; power on light.
5) Pump circuit breaker(s).

2.4 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.

B. Motors for submersible pumps are to be hermetically sealed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump-pump installation.

3.2 INSTALLATION

A. Pump Installation Standards: Comply with HI 14.4 for installation of sump pumps.
B. Wiring Method: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221414 "Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 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.

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 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust control set points.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test, inspect, and adjust components, assemblies, and equipment installations, including connections.
B. Tests and inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Pumps and controls will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.7 DEMONSTRATION

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

3.8 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 221429

SECTION 223400 - FUEL-FIRED, 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, direct-vent, gas-fired, storage, domestic-water heater.
   2. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
   3. Domestic-water heater accessories.

1.3 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:
   1. Include diagrams for power, signal, and control wiring.

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 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, gas-fired, 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 fuel-fired, domestic-water heaters to include in 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 fuel-fired, 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, Gas-Fired, Storage, Domestic-Water Heaters:
         1) Storage Tank: Five years.
         2) Controls and Other Components: One year(s).
      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: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
C. ASME Compliance:
   1. 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.
   2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
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, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Direct-Vent, Gas-Fired, Storage, Domestic-Water Heaters:
   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 Water Heaters.
      b. Bradford White Corporation.
      c. Lochinvar, LLC.
      d. Rheem Manufacturing Company.
      e. State Industries.
   2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
   3. Standard: ANSI Z21.10.1/CSA 4.1.
   4. Storage-Tank Construction: Steel.
      a. Tappings: ASME B1.20.1 pipe thread.
      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. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with ASHRAE/IES 90.1.
   e. Jacket: Steel with enameled finish.
   f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
   g. Burner: For use with direct-vent, gas-fired, domestic-water heaters and natural-gas fuel.
   h. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
   i. Temperature Control: Adjustable thermostat.
   j. Combination Temperature-and-Pressure Relief Valve: ANSI Z21.22/CSA 4.4. 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 valve with sensing element that extends into storage tank.
6. Direct-Vent System: Through-wall or roof, coaxial- or double-channel vent assembly with domestic-water heater manufacturers' outside intake/exhaust screen.

B. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
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: ANSI Z21.10.3/CSA 4.3.
4. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
5. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.
   a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
      2) NPS 2-1/2 (DN 65) 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. 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. Lining: Glass complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

6. Factory-Installed, Storage-Tank Appurtenances:
   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
   c. Drain Valve: Corrosion-resistant metal with hose-end connection.
   d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
   e. Jacket: Steel with enameled finish.
   f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
   g. Temperature Control: Adjustable thermostat.
   h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
   i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. 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.
7. Draft Hood: Draft diverter, complying with ANSI Z21.12.

C. Capacity and Characteristics:
   1. Refer to schedule on drawings.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. AMTROL, Inc.
      b. Taco Comfort Solutions.
   2. Source Limitations: Obtain domestic-water heaters 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 90.2.
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.
F. 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."
   1. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.
H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.
I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
J. Combination Temperature-and-Pressure Relief Valves: 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.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
K. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.
   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.
L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled 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. 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 INSTALLATION OF DOMESTIC-WATER HEATER

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
   1. Exception: Omit concrete bases for commercial 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 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 gas-fired, domestic-water heaters in accordance with NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. 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.

E. Install combination temperature-and-pressure relief valves in water piping for 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.

F. 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 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."

G. Install thermometer on outlet piping of 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 domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each

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 piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
J. Fill domestic-water heaters with water.
K. Charge domestic-water expansion tanks with air to required system pressure.
L. 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 shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."
B. Comply with requirements for fuel-oil piping specified in Section 231113 "Facility Fuel-Oil Piping."
C. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."
D. Drawings indicate general arrangement of piping, fittings, and specialties.
E. Where installing piping adjacent to fuel-fired, 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. 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.
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 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters. Training shall be a minimum of two hour(s).

END OF SECTION 223400

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

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. Wall-mounted water closets.
   2. Flushometer valves.
   3. Toilet seats.
   4. Supports.

1.3 DEFINITIONS

A. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

B. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.4 ACTION SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than six of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:
   1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
   2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
   3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
   4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
   5. Comply with ASME A112.6.1M for water-closet supports.

6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud: P-1.
   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 Standard.
      b. Kohler Co.
      c. TOTO USA, INC.
      d. Zurn Industries, LLC.
   2. Source Limitations: Obtain water closets from single source from single manufacturer.
   3. Bowl:
      a. Material: Vitreous china.
      b. Type: Siphon jet.
      c. Style: Flushometer valve.
      d. Mounting Height: Standard or ADA compliant depending on location, refer to architectural drawings.
      e. Rim Contour: Elongated.
      f. Water Consumption: 1.28 gal. per flush.
      g. Spud Size and Location: NPS 1-1/2; top.
      h. Color: White.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Solenoid Actuated:
   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. Sloan Valve Company.
      b. Zurn Industries, LLC.
   2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
   3. Minimum Pressure Rating: 125 psig.
   4. Features: Include integral check stop and backflow-prevention device.
   5. Material: Brass body with corrosion-resistant components.
   6. Style: Exposed.
   7. Exposed Flushometer-Valve Finish: Chrome-plated.
   8. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
   9. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
   10. Consumption: 1.28 gal. per flush.
   11. Minimum Inlet: NPS 1.
   12. Minimum Outlet: NPS 1-1/4.

2.4 TOILET SEATS

A. Toilet Seats:

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 Standard.
   b. Bemis Manufacturing Company.
   c. Church Seats; Bemis Manufacturing Company.
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.5 SUPPORTS

A. Water-Closet Carrier:

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. Wade; a subsidiary of McWane Inc.
   e. Zurn Industries, LLC.
   f. Josam Company.
2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space, where required.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
B. Examine walls and floors for suitable conditions where water closets will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
4. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:
1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install actuators in locations easily reachable for people with disabilities.
4. Install new batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

F. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13 - COMMERCIAL LAVATORIES

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. Vitreous-china, wall-mounted lavatories.
   2. Automatically operated lavatory faucets.
   3. Supply fittings.
   4. Waste fittings.
   5. Lavatory supports.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Servicing and adjustments of automatic faucets.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory - Ledge Back, Rectangular, Vitreous China, Wall Mounted P-3:
   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 Standard.
      b. Kohler Co.
      c. TOTO USA, INC.
      d. Zurn Industries, LLC.
   2. Fixture:

a. Standard: ASME A112.19.2/CSA B45.1.
b. Type: For wall hanging.
c. Nominal Size: Rectangular, 21-1/4 by 18-1/4 inches.
d. Faucet-Hole Punching: Three holes, 4-inch centers.
e. Faucet-Hole Location: Top.
f. Color: White.
g. Mounting Material: Chair carrier.

3. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.
4. Lavatory Mounting Height: Standard and Handicapped/elderly in accordance with ICC A117.1, refer to architectural drawings for mounting heights.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

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

B. Lavatory Faucets - Automatic Type: Battery Powered Electronic Sensor Operated, Mixing,:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Sloan Valve Company.
   b. Zurn Industries, LLC.
2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body type in "Body Type" Subparagraph below must match fixture hole punching.
5. Body Type: Three hole.
6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid, gooseneck type.
11. Spout Outlet: Vandal-resistant, spray.
12. Drain: Not part of faucet.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
E. C. Operation: Loose key.
F. Risers:
   1. NPS 1/2.
   2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.4 WASTE FITTINGS
A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
C. Trap:
   1. Size: NPS 1-1/4.
   2. Material:
      a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.

2.5 LAVATORY SUPPORTS
A. Lavatory Carrier:
   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. Wade; a subsidiary of McWane Inc.
      e. Zurn Industries, LLC.
      f. Josam Company.
   2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
B. Examine counters and walls for suitable conditions where lavatories will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install lavatories level and plumb in accordance with roughing-in drawings.
B. Install supports, affixed to building substrate, for wall-mounted lavatories.
C. Indicate on Drawings those lavatories that are required to be accessible.
D. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal

protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."

F. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
G. Indicate on Drawings those lavatories that are required to be accessible.
H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.
B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed lavatories and fittings.
D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Service sinks.
   2. Kitchen/utility sinks.
   3. Handwash sinks.
   4. Manually operated sink faucets.
   5. Automatically operated sink faucets.
   6. Supply fittings.
   7. Waste fittings.
   8. Sink supports.
   9. Grout.

B. Related Requirements:
   1. Section 114000 "Foodservice Equipment" for NSF-compliant foodservice and handwash sinks.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. Servicing and adjustments for automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

A. Service Sinks - Molded Stone, Floor Mounted:
   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. Fiat Products.
      b. Florestone Products Co., Inc.
   2. Source Limitations: Obtain sinks from single source from single manufacturer.
   3. Fixture:
      a. Standard: ASME A112.18.2/CSA B125.2.
      b. Shape: Square.
      c. Nominal Size: 24 by 24 inches.
      d. Height: 10 inches.
      e. Indicate front dimension on rectangular sink if rim guard is to be only on one side.
      f. Rim Guard: On all top surfaces.
      g. Color: Not applicable.
      h. Drain: Grid with NPS 3 outlet.
   4. Mounting: On floor and flush to wall.

B. Service Sinks - Enameled Cast Iron, Trap Standard Mounted:
   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 Standard.
      b. Commercial Enameling Company.
      c. Kohler Co.
      d. Zurn Industries, LLC.
   2. Source Limitations: Obtain sinks from single source from single manufacturer.
   3. Fixture:
      a. Standard: ASME A112.19.1/CSA B45.2.
      b. Type: Service sink with back.
      c. Back: Two faucet holes.
      d. Nominal Size: 24 by 20 inches.
      e. Color: White.
      f. Mounting: NPS 3 P-trap standard with grid strainer inlet, cleanout, and floor flange.
      g. Rim Guard: On front and sides.

2.2 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Under Counter Mounted:
   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 Tabco.
      b. Elkay.
      c. Franke.
      d. Just Manufacturing.
   2. Source Limitations: Obtain sinks from single source from single manufacturer.

3. Fixture:
   a. Standard: ASME A112.19.3/CSA B45.4.
   b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back.
   c. Number of Compartments: One.
   d. Overall Dimensions: 23-1/2 by 18-1/4 by 5-3/8 inches.
   e. Material: 18 gauge, Type 304 stainless steel.
   f. Compartment:
      1) Dimensions: 21 by 15-3/4 by 5-3/8 inches.
      2) Drain: Grid with NPS 1-1/2 tailpiece and twist drain.
      3) Drain Location: Centered in compartment.
      4) Depth: Wheelchair accessible.
4. Faucet(s):
   a. Number Required: One.
   b. Mounting: On ledge.
5. Supply Fittings:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      1) Operation: Loose key.
      2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
6. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      1) Size: NPS 1-1/2.
      2) Material:

         a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.
         b) Stainless steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless steel tube to wall; and stainless steel wall flange.
7. Mounting: Under counter with sealant.

B. Tuba Sinks - Stainless Steel, Freestanding:
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. Griffin Products, Inc.
2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:
   a. Standards:
      1) ASME A112.19.3/CSA B45.4.
      2) NSF 2.
   b. Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
   c. Number of Compartments: One.
   d. Overall Dimensions: 45 inches x 33-1/2 inches x 36 inches.
   e. Material: 14 gauge, Type 304 stainless steel.
   f. Compartment:

1) Dimensions: 42 inches x 30 inches x 30 inches.
2) Drain: Grid with NPS 2 tailpiece and twist drain.
3) Drain Location: Centered in compartment.

4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
5. Faucet(s):
   a. Number Required: One.
   b. Mounting: On backsplash.
6. Supply Fittings:
   a. Standard: ASME A112.18.1/CSA B125.1.
   b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
      1) Operation: Loose key.
      2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
7. Waste Fittings:
   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap(s):
      1) Size: NPS 2.
      2) Material:
         a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.
         b) Stainless steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless steel tube to wall; and stainless steel wall flange.

2.3 HANDWASH SINKS

A. Handwash Sinks - Stainless Steel: Art Room Sink.
   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 Tabco.
      b. Franke.
      c. Griffin Products, Inc.
   2. Source Limitations: Obtain sinks from single source from single manufacturer.
   3. Fixture:
      a. Standards:
         1) ASME A112.19.3/CSA B45.4.
         2) NSF 61.
      b. Type: Wall-mounted stainless steel basin with radius corners, back for faucet, and support brackets.
      c. Overall Dimensions: 60 by 20 by 25-3/4 inches.
      d. Material: 14 gauge, Type 304 stainless steel.
   4. Facuet: Three, back wall mounted.
   5. Supply Fittings: Comply with requirements in "Supply Fittings" Article.
   6. Waste Fittings: Comply with requirements in "Waste Fittings" Article.
   7. Support: Type II sink carrier.
   8. Mounting Height: Accessible in accordance with ICC A117.1.

2.4 MANUALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Manual Type: Two-handle mixing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Chicago Faucets; Geberit Group.
   b. Elkay.
   c. Speakman Company.
   d. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Centerset.
6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): 4-inch wrist blade.
11. Spout Type: Swivel gooseneck.
12. Vacuum Breaker: Not required for hose outlet.
13. Spout Outlet: Aerator.

C. Commercial Service Sink Faucets - Manual Type: For Service Sinks and Tuba Sink.

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 Standard.
   b. Fiat Products.
   c. Speakman Company.
   d. T&S Brass and Bronze Works, Inc.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
4. Faucet:
   a. Standards:
      1) ASME A112.18.1/CSA B125.1.
      2) NSF 61 and NSF 372.
      3) ICC A117.1.

4) ASSE 1001 (VB).
b. Finish: Polished chrome plated.
c. Handles: Lever.
d. Cartridges: Ceramic.
e. Brace: Adjustable top brace.
5. Vacuum Breaker: Required for hose outlet.
6. Spout Outlet: Hose thread in accordance with ASME B1.20.7.

2.5 AUTOMATICALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Automatic Type: Battery-powered, electronic-sensor-operated, mixing,.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
a. Elkay
b. Kohler Co.
c. Speakman Company.
d. T&S Brass and Bronze Works, Inc.
e. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
6. Body Type: Single hole.
7. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
8. Finish: Polished chrome1 plate.
9. Maximum Flow Rate: 1.5 gpm.
10. Mounting Type: Back/wall.
11. Spout Type: Rigid, gooseneck.
12. Spout Outlet: Aerator.
13. Thermostatic Mixing Valve: Below deck, with check valves.
14. Control Module: Below deck, water-resistant module with internal flow setting switches.
15. Drain: Not part of faucet.

2.6 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.
C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
E. Operation: Loose key.
F. Risers:
1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.7 WASTE FITTINGS
A. Standard: ASME A112.18.2/CSA B125.2.
B. Drain: Grid type with offset and straight tailpiece.
C. Trap:
1. Size: Refer to drawings.
2. Material:
a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.8 SINK SUPPORTS
A. Sink Carrier:
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. Source Limitations: Obtain sink supports from single source from single manufacturer.
3. Standard: ASME A112.6.1M.

2.9 GROUT
A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000 psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.
B. Install supports, affixed to building substrate, for wall-hung sinks.
C. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.
D. Set floor-mounted sinks in leveling bed of cement grout.
E. Install water-supply piping with stop on each supply to each sink faucet.
   1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
   2. Install stops in locations where they can be easily reached for operation.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

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

3.5 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.
B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed sinks and fittings.
D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224223 - COMMERCIAL SHOWERS

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. Individual showers.
   2. Shower heads and shower valves.
   3. Grout.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.
B. PMMA: Polymethyl methacrylate; also known as "acrylic."

1.4 ACTION SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For shower valves to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
   2. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Shower valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 INDIVIDUAL SHOWERS

A. Individual, One-Piece, FRP Showers without Top:

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. Florestone Products Co., Inc.
   b. Kohler Co.
   c. LASCO Bathware.
2. Source Limitations: Obtain FRP showers without top from single source from single manufacturer.
3. General: FRP shower enclosure with valve and receptor and appurtenances.
4. Standard: CSA B45.5/IAPMO Z124.
5. Style: Handicapped/accessible.
6. Shower Nominal Size and Shape: 60 by 36 inches rectangular.
7. Color: White.
8. Outlet: Drain with NPS 2 outlet.
9. Shower Rod and Curtain: Required.
10. Grab Bar: ASTM F446, mounted on support area back wall.

2.3 SHOWER HEADS AND SHOWER VALVES

A. Shower Head with Single-Handle, Pressure-Balanced Mixing 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. American Standard.
      b. Kohler Co.
      c. Moen Incorporated.
      d. Speakman Company.
      e. Symmons Industries, Inc.
      f. Zurn Industries, LLC.
   2. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
   3. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; diverting valve check stops; and hose with handheld shower head on sliding rod shower head.
   4. Shower Valve:
      a. Standards:ASME A112.18.1/CSA B125.1and ASSE 1016/ASME A112.1016/CSA B125.16.
      b. Body Material: Solid brass.
      c. Finish: Polished chrome plate.
      d. Mounting: Exposed.
      e. Operation: Single-handle, push-pull or twist or rotate or metering control.
      f. Antiscald Device: Integral with mixing valve.
      g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
   5. Supply Connections: NPS 1/2.
   6. Shower Head:
      a. Standard: ASME A112.18.1/CSA B125.1.
      b. Type: Ball joint with arm and flange.
      c. EPA WaterSense: Required.
      d. Shower Head Maximum Flow Rate: 2.0 gpm.
      e. Shower Head Material: Metallic with chrome-plated finish.

f. Spray Pattern: Fixed.
g. Integral Volume Control: Required.
h. Temperature Indicator: Not required.

2.4 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5000 psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
B. Examine walls and floors for suitable conditions where showers will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.
B. Install showers level and plumb.
C. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" Install valves in locations that are accessible for ease of operation.
D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
E. Set shower receptors and shower basins in leveling bed of cement grout.
F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220500 "Common Work Results for Plumbing."
G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
B. Adjust water pressure at shower valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of showers, inspect and repair damaged finishes.
B. Clean showers, shower valves, and other fittings with manufacturers' recommended cleaning methods and materials.
C. Provide protective covering for installed fixtures and fittings.
D. Do not allow use of showers for temporary facilities unless approved in writing by Owner.

END OF SECTION 224223

SECTION 224500 - EMERGENCY 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. Section Includes:
   1. Eyewash equipment.

1.3 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
C. Tepid: Between 60 and 100 deg F.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
B. Shop Drawings:
   1. Plans, elevations, sections, and mounting details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
B. Emergency fixture third-party certification documentation.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.
D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 EYEWASH EQUIPMENT

A. Eyewash Units - Deck or Wall Mounted, Swivel Type, Plumbed:
   1. Source Limitations: Obtain eyewash units, deck mounted, swivel type, plumbed, from single manufacturer.
   2. Capacity: Not less than 0.4 gpm for at least 15 minutes.
   3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
   4. Control-Valve Actuator: Movement of spray-head assembly to position over sink.
   5. Spray-Head Assembly: Two spray heads with offset piping. Provide stainless steel dust cover for each spray head.
   6. Mounting: Deck mounted next to sink.
   7. Unit shall be complete with thermostatic mixing valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATON OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.
B. Install fixtures level and plumb.
C. Fasten fixtures to substrate.
D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
   1. Exceptions:
      a. Omit shutoff valve on supply to group of plumbing fixtures that includes emergency equipment.
      b. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.
E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."
F. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.3 PIPING CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."
B. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. 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.
5. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.6 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224500

SECTION 224716 - PRESSURE 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. Section Includes:
   1. Pressure water coolers.
   2. Bottle filling stations.
   3. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler and bottle filling station.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include diagrams for power wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers and bottle filling stations to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filter Cartridges: Provide one spare filter cartridge for each water cooler and bottle filler installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:
   1. Pressure water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or 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.
   2. Comply with ASHRAE 34 for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
   3. Comply with UL 399.
   4. Comply with ASME A112.19.3/CSA B45.4.

5. 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.
6. Comply with NSF 42 and NSF 53 for water filters for water coolers and bottle filling stations.
7. Comply with ICC A117.1 for accessible water coolers and bottle filling stations.

2.2 PRESSURE WATER COOLERS

A. Pressure Water Coolers - Surface Wall-Mounted, Bi-Level, Filtered Stainless Steel.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      a. Elkay.
      b. Halsey Taylor.
   2. Source Limitations: Obtain surface wall-mounted, stainless steel, pressure water coolers from single source from single manufacturer.
   3. Type: Vandal resistant.
   4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
   5. Control: Push button.
   6. Bottle Filler: Sensor activation, with 20-second automatic shutoff timer: Fill rate 0.5 to 1.5 gpm <Insert value>.
   7. Drain: Grid with NPS 1-1/4 tailpiece.
   8. Supply: NPS 3/8 with shutoff valve.
   9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
   10. Filter: One or more water filters with capacity sized for unit peak flow rate.
   11. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
   12. Support: Water-cooler carrier.
   13. Water-Cooler Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.
   14. Capacities and Characteristics:
      a. Cooled Water: 8 gph.
      b. Ambient-Air Temperature: 90 deg F.
      c. Inlet-Water Temperature: 80 deg F.
      d. Cooled-Water Temperature: 50 deg F.
      e. Electrical Characteristics:

         1) Volts: 120 V ac.
         2) Phase: Single.
         3) Hertz: 60 Hz.

2.3 BOTTLE FILLING STATION

A. Bottle Filling Station - Recessed, Wall-Mounted, Stainless Steel: 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. Elkay.
b. Halsey Taylor.

2. Source Limitations: Obtain recessed, wall-mounted, stainless steel, bottle filling stations from single source from single manufacturer.
3. Bottle Filler: Sensor activation, with 20-second automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
4. Drain: Grid with NPS 1-1/4 tailpiece.
5. Supply: NPS 3/8 with shutoff valve.
6. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
7. Filter: One or more water filters with capacity sized for unit peak flow rate.
8. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
   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.
9. Capacities and Characteristics:
   a. Cooled Water: 8 gph.
   b. Ambient-Air Temperature: 90 deg F.
   c. Inlet-Water Temperature: 80 deg F.
   d. Cooled-Water Temperature: 50 deg F.
   e. Electrical Characteristics:
      1) Volts: 120 V ac.
      2) Phase: Single.
      3) Hertz: 60 Hz.
   f. Ventilation Grille: Stainless steel.
10. Support: Provide manufacturer's support frame attached to substrate.
11. Bottle Filling Station Mounting Height: Accessible in accordance with ICC A117.1.

2.4 SUPPORTS

A. Water-Cooler Carrier:
   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. Zurn Industries, LLC.
   2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
B. Examine walls for suitable conditions where fixtures will be installed.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and bottle filling stations to mounting frames.
D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball 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 wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220500 "Common Work Results for Plumbing."
G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
C. Install ball shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping"
D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.
B. Adjust pressure water-cooler temperature settings.

3.6 CLEANING

A. After installing fixture, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
C. Provide protective covering for installed fixtures.
D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224716

SECTION 226600 - CHEMICAL-WASTE SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES

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 pipe and fittings.
   2. Joining materials.
   3. Piping specialties.
   4. Neutralization tanks.

1.3 DEFINITIONS

A. FPM: Vinylidene fluoride (hexafluoropropylene copolymer rubber).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Shop Drawings: For neutralization system and leak-detection system.
   1. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Pipe sizes, locations, and elevations.
   2. Other piping in same trench and clearances from sewerage system piping.
   3. Interface and spatial relationship between piping and proximate structures.
B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For chemical-waste specialties and neutralization tanks 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. Neutralization-Tank Limestone: Equal to 200 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb bags.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.
B. Do not store plastic pipe or fittings in direct sunlight.

C. Protect pipe, fittings, and seals from dirt and damage.

1.9 FIELD CONDITIONS

A. Interruption of Existing Chemical-Waste Service: Do not interrupt chemical-waste service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary chemical-waste service in accordance with requirements indicated:
   1. Notify Construction Manager and Owner no fewer than five days in advance of proposed interruption of chemical-waste service.
   2. Do not proceed with interruption of chemical-waste service without Construction Manager's or Owner's written permission.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
B. NFPA Compliance: Comply with NFPA 70.

2.2 PERFORMANCE REQUIREMENTS

A. Single-Wall Piping Pressure Rating: 10 feet headof water for 30 minutes.

2.3 SINGLE-WALL PIPE AND FITTINGS

A. CPVC Drainage Pipe and Fittings: ASTM F2618, pipe and drainage-pattern 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. Charlotte Pipe and Foundry Company.
      b. Spears Manufacturing Company.
   2. Source Limitations: Obtain pipe and fittings from single source from single manufacturer.
B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, and gaskets; compatible with piping and system liquid; made for joining different piping materials.

2.4 JOINING MATERIALS

A. Couplings: Assemblies with combinations of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.
B. Adapters and Transition Fittings: Assemblies with combinations of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.
C. Flanges: Assemblies of companion flanges and gaskets complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.
D. Solvent Cement for Joining CPVC Piping: ASTM F493. Include primer in accordance with ASTM F656.

2.5 PIPING SPECIALTIES

A. Plastic Dilution Traps:

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. IPEX USA LLC.
   b. Orion Fittings; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.
2. Source Limitations: Obtain traps from single source from single manufacturer.
3. Material: Corrosion-resistant PP, with removable base.
4. End Connections: Mechanical joint.
5. Dilution Tanks: 1-gal. capacity, with clear base unless colored base is indicated; with two NPS 1-1/2 top inlets and one NPS 1-1/2 side outlet.
6. Small Dilution Jars: 1-pint capacity, with clear base unless colored base is indicated; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.
7. Large Dilution Jars: 1-quart capacity; with NPS 1-1/2 top inlet and NPS 1-1/2 side outlet.

B. Glass, Drain-Line, Interceptor Traps:
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. Schott North America, Inc.
2. Source Limitations: Obtain traps from single source from single manufacturer.
3. Standard: ASTM C1053.
4. Type: Drum trap.
5. Size: NPS 1-1/2, NPS 2 by NPS 1-1/2, or NPS 2, as required to match connecting piping.

C. Corrosion-Resistant Traps:
1. Type: P-trap or drum trap.
2. Size: NPS 1-1/2 or NPS 2, as required to match connected piping.
3. High-Silicon Iron: ASTM A861, with horizontal outlet and hub-and-plain or plain ends to match connecting piping.
4. PP: ASTM D4101, with mechanical-joint pipe connections.
5. PVDF: ASTM D3222, with mechanical-joint pipe connections.
6. Glass: ASTM C1053, with coupling pipe connections.

D. Valves in "Plastic Backwater Valves" Paragraph below are available in NPS 3 (DN 80) only.

E. PP Sink Outlets:
1. Description: NPS 1-1/2, with clamping device, stopper, and 7-inch-high overflow fitting.

F. Glass Sink Outlets:
1. Description: NPS 1-1/2; with sink assembly of outlet, strainer, gasket, and locknut; overflow fitting of length indicated; and tailpiece assembly of borosilicate glass and locknut.
2. 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. Schott North America, Inc.
3. Source Limitations: Obtain sink outlets from single source from single manufacturer.
4. Standard: ASTM C1053 components for field assembly.

2.6 NEUTRALIZATION TANKS

A. Plastic Neutralization Tanks:

1. Description: Corrosion-resistant plastic materials; with removable, gastight cover; interior, sidewall, dip-tube inlet; outlet; vent; and threaded or flanged, sidewall pipe connections.
2. 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. Orion Fittings; A Watts Water Technologies Company.
   b. WATTS; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.
3. Source Limitations: Obtain tanks from single source from single manufacturer.
4. Material: HDPE or ASTM D4101 PP.
5. Tank Capacity: Refer to schedule on drawings.
6. Dip Tube: On outlet pipe instead of inlet pipe.
7. Extension: HDPE, PE, or PP.
8. Traffic Cover: Light-duty plastic, bolted.
9. Limestone: Chips or lumps, with more than 90 percent calcium carbonate content and 1- to 3-inch diameter.

PART 3 - EXECUTION

3.1 EARTHWORK

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

3.2 CONCRETE BASES

A. Equipment Mounting:

1. Install neutralization tanks on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Anchor neutralization tanks to concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 19-inch centers around full perimeter of base.
2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 PIPING INSTALLATION

A. Chemical-Waste Piping Inside the Building:

1. Install piping adjacent to equipment, accessories, and specialties, to allow space for service and maintenance.
2. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
3. Flanges may be used on aboveground piping unless otherwise indicated.

4. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
5. 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.
6. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
7. Install piping at indicated slopes.
8. Install piping free of sags and bends.
9. Install fittings for changes in direction and branch connections.
10. Verify final equipment locations for roughing-in.
11. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."
12. 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."
13. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 PIPING SPECIALTY INSTALLATION

A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use fittings of same material as sewer pipe at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in pipe.

3.5 JOINT CONSTRUCTION

A. Chemical-Waste Piping Inside the Building:
   1. Plastic-Piping Fusion Joints: Make PP drainage-piping joints in accordance with ASTM F1290.
   2. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

3.6 HANGER AND SUPPORT INSTALLATION

A. Pipe sizes in this article refer to aboveground single-wall piping.
B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices. Install the following:
   1. Vertical Piping: MSS Type 8 or MSS Type 42 riser clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52 spring hangers.
C. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for installation of supports.

D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
E. Support vertical piping and tubing at base and at each floor.
F. Rod diameter may be reduced one size for double-rod hangers, to minimum of 3/8 inch.
G. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 36 inches with 3/8-inch rod.
   2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): 42 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5 (DN 100 and DN 125): 48 inches with 5/8-inch rod.
   4. NPS 6 (DN 150): 48 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12 (DN 200 to DN 300): 48 inches with 7/8-inch rod.
H. Install supports for vertical CPVC piping every 48 inches.
I. Support piping and tubing not listed above in accordance with MSS SP-58.

3.7 NEUTRALIZATION TANK INSTALLATION
A. Install interior neutralization tanks on smooth and level concrete base. Include full initial charge of limestone.

3.8 CONCRETE PLACEMENT
A. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for concrete supports.
B. Place cast-in-place concrete in accordance with ACI 318/318R.

3.9 PIPING CONNECTIONS
A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Make connections to existing piping, so finished Work complies as nearly as practical with requirements specified for new Work.
C. Use commercially manufactured wye fittings for sewerage piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
D. Protect existing piping to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.
E. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.10 LABELING AND IDENTIFICATION
A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for labeling of equipment and piping.

3.11 CLEANING
A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Clean piping by flushing with potable water.

3.12 FIELD QUALITY CONTROL

A. Inspect interior of sewerage piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place and again at completion of Project.
   1. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between inspection points.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
      d. Hydrostatic Tests for Drainage Piping:
         1) Allowable leakage is a maximum of 50 gal./inch of nominal pipe size per mile of pipe during 24-hour period.
         2) Close openings in system and fill with water.
         3) Purge air and refill with water.
         4) Disconnect water supply.
         5) Test and inspect joints for leaks.
      e. Air Tests for Drainage Piping: Comply with UNI-B-6.
   2. Leaks and loss in test pressure constitute defects that must be repaired.
   3. Submit separate reports for each test.

B. Replace leaking sewerage piping using new materials, and repeat testing until leakage is within allowances specified.

C. Perform tests and inspections with the assistance of a factory-authorized service representative:

D. Tests and Inspections:
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect assembled neutralization tanks and their installation, including piping and electrical connections, and to assist in testing.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Chemical-waste piping will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.13 DEMONSTRATION

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

3.14 PIPING SCHEDULE

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

B. Single-Wall, Chemical-Waste Sewerage and Vent Piping: Use the following piping materials for each size range:
   1. NPS 1-1/2 to NPS 6 CPVC: Drainage pipe and fittings and solvent-cemented joints.

END OF SECTION 226600

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.

2.6 VARIABLE SPEED MOTOR CONTROLLERS

A. Refer to Section 26 29 23, VARIABLE-FREQUENCY MOTOR CONTROLLERS for specifications.

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 13, PENETRATION 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 16 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 13, PENETRATION 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.

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 230516 - EXPANSION FITTINGS AND LOOPS 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. Expansion-compensator packless expansion joints.
   2. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   3. Alignment Guide Details: Detail field assembly and attachment to building structure.
   4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
C. Welding certificates.
D. Product Certificates: For each type of expansion joint, from manufacturer.
E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

A. Metal, Expansion-Compensator Packless Expansion 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. Adsco Manufacturing LLC.
   b. Flexicraft Industries.
   c. Flex-Weld, Inc.
   d. Hyspan Precision Products, Inc.
   e. Metraflex, Inc.
   f. Approved Equal.
2. Minimum Pressure Rating: 175 psig unless otherwise indicated.
3. Configuration for Copper Tubing: Two ply, phosphor-bronze bellows with copper pip ends.
   a. End connections for copper tubing NPS 2 and Smaller: Solder joint.
   b. End connections for copper tubing NPS 2-1/2 to NPS 4: Threaded.
4. Configuration for Steel Piping: Two ply, stainless steel bellows; steel pipe end connections; and carbon steel shroud.
   a. End connections for steel pipe NPS 2 and Smaller: Threaded.
   b. End connections for steel pipe NPS 2-1/2 to NPS 4: Flanged.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:
   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. Adsco Manufacturing LLC.
      b. Advanced Thermal Systems, Inc.
      c. Flex-Hose Co., Inc.
      d. Flexicraft Industries.
      e. Flex-Weld, Inc.
      f. Hyspan Precision Products, Inc.
      g. Metraflex, Inc.
      h. Approved Equal
   2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:
   1. Steel Shapes and Plates: ASTM A 36/A 36M.
   2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
   3. Washers: ASTM F 844, steel, plain, flat washers.
   4. Mechanical Fasteners: Insert-wedge type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
      a. Stud: Threaded, zinc-coated carbon steel.
      b. Expansion Plug: Zinc-coated steel.
      c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.
B. Install metal bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 ALIGNMENT GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
C. Attach guides to pipe and secure guides to building structure.
D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
E. Anchor Attachments:
    1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
    2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
    1. Anchor Attachment to Steel Structural Members: Attach by welding.
    2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 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] [and] [rough brass] finish and setscrew fastener.
B. One Piece, Deep Pattern Type: Deep drawn, box shaped brass with chrome-plated finish and spring clip fasteners.
C. One Piece, Stamped Steel Type: With chrome-plated finish and spring clip fasteners.
D. Split Casting Brass Type: With polished, chrome-plated and rough brass finish and with concealed hinge and setscrew.
E. Split Plate, Stamped Steel Type: With chrome-plated finish, concealed hinge, and spring clip fasteners.

2.2 FLOOR PLATES

A. One Piece Floor Plates: Cast-iron flange with holes for fasteners.
B. Split Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
   1. Escutcheons for New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern type.
      b. Chrome-Plated Piping: One piece, cast brass 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 230519 - METERS AND GAGES 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. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Sight flow indicators.

B. Related Sections:
   1. Division 23 Section "Facility Natural Gas Piping" for gas meters.

1.3 SUBMITTALS

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

B. Product Certificates: For each type of meter and gage, from manufacturer.

C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal Case, Industrial Style, Liquid-in-Glass Thermometers:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Flo Fab Inc.
      b. Trerice, H. O. Co.
      c. Weiss Instruments, Inc.
      d. Winters Instruments - U.S.
      e. Approved equal
   2. Standard: ASME B40.200.
   3. Case: Cast aluminum; 7 inch nominal size unless otherwise indicated.
   4. Case Form: Adjustable angle unless otherwise indicated.
   5. Tube: Glass with magnifying lens and blue or red organic liquid.
   6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
   7. Window: Glass or plastic.
   8. Stem: Aluminum and of length to suit installation.
      a. Design for Thermowell Installation: Bare stem.
   9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct Mounted, Metal Case, Dial Type Pressure Gages:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. AMETEK, Inc.; U.S. Gauge
b. Flo Fab Inc.
c. Trerice, H. O. Co.
d. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
e. Weiss Instruments, Inc.
f. Winters Instruments - U.S.
g. Approved equal
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2 inch nominal diameter.
4. Pressure Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom outlet type unless back outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston type surge dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flow Design, Inc.
   2. Miljoco Corporation
   3. National Meter, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.
   9. Approved equal
B. Description: Test station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
D. Thread Size: NPS ¼ or NPS 1/2, ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.6 TEST PLUG 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. Flow Design, Inc.
   2. Miljoco Corporation
   3. National Meter, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.
   9. Approved equal
B. Furnish one test plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
C. Low-Range Thermometer: Small, bimetallic insertion type with 1 to 2 inch diameter dial and tapered end sensing element. Dial range shall be at least 25 to 125 deg F.
D. Pressure Gage: Small, Bourdon tube insertion type with 2 to 3 inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.
E. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Archon Industries, Inc.

2. Dwyer Instruments, Inc.
3. Emerson Process Management; Brooks Instrument
4. Ernst Co., John C., Inc.
5. Ernst Flow Industries
6. KOBOLD Instruments, Inc. - USA; KOBOLD Messing GmbH.
7. OPW Engineered Systems; a Dover company
8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown
9. Approved equla

B. Description: Piping inline installation device for visual verification of flow.
C. Construction: Bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
D. Minimum Pressure Rating: 150 psig.
E. Minimum Temperature Rating: 200 deg F.
F. End Connections for NPS 2 and Smaller: Threaded.
G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.
D. Fill thermowells with heat transfer medium.
E. Install direct mounted thermometers in thermowells and adjust vertical and tilted positions.
F. Install direct mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
G. Install valve and snubber in piping for each pressure gage for fluids.
H. Install test plugs in piping tees.
I. Install flow indicators in piping systems in accessible positions for easy viewing.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled Water Piping: 0 to 250 deg F.
B. Scale Range for Heating, Hot Water Piping: 0 to 250 deg F.

3.5 PRESSURE GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled Water Piping: 0 to 100 psi.
B. Scale Range for Heating, Hot Water Piping: 0 to 100 psi.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Iron ball valves.
   3. High performance butterfly valves.
   4. Bronze swing check valves.
   5. Iron swing check valves.
   6. Bronze gate valves.
   7. Iron gate valves.
   8. Bronze globe valves.
   9. Iron globe valves.
   10. Chainwheels.

B. Related Sections:
   1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
   2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.
G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

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

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

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

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

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

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller.
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
   3. Butterfly Valves: With extended neck.

F. Valve End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Solder Joint: With sockets according to ASME B16.18.
   3. Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
   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. Crane Co.; Crane Valve Group; Crane Valves.
      b. Hammond Valve.
      c. Milwaukee Valve Company.

d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.3 IRON BALL VALVES

A. Class 125, Iron 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. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A 126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE or TFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.4 HIGH PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single Flange, High Performance Butterfly 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. Bray Controls; a division of Bray International.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Process Development & Control, Inc.
f. Approved equal

2. Description:
a. Refer to drawings.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

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. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: PTFE or TFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:
   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. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Legend Valve.
      f. Milwaukee Valve Company.
      g. NIBCO INC.
      h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-71, Type I.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. Body Design: Clear or full waterway.
      d. Body Material: ASTM A 126, gray iron with bolted bonnet.
      e. Ends: Flanged.
      f. Trim: Bronze.
      g. Gasket: Asbestos free.

2.7 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate 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. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Crane Co.; Crane Valve Group; Stockham Division.
      d. Hammond Valve.
      e. Milwaukee Valve Company.

f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron bronze, or aluminum.

2.8 IRON GATE VALVES

A. Class 125, NRS, Iron Gate 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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Class 125, OS&Y, Iron Gate 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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.

g. Packing and Gasket: Asbestos free.

2.9 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Nonmetallic Disc:
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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. NIBCO INC.
d. Red-White Valve Corporation.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron bronze, or aluminum.

2.10 IRON GLOBE VALVES

A. Class 125, Iron 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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.11 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.
3. Trumbull Industries.
B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve.
4. 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. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly or gate valves.
   2. Butterfly Valve Dead End Service: Single flange (lug) type.
   3. Throttling Service except Steam: Globe or butterfly valves.
   4. Pump-Discharge Check Valves:
      a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
      b. NPS 2-1/2 and Larger: Iron swing check valves with lever and weight or with spring or iron, center guided, metal seat check valves.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder joint valve end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED, HEATING, AND DUAL TEMPERATURE WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   1. Bronze Valves: May be provided with solder joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with bronze trim.
   3. Bronze Swing Check Valves: Class 125 nonmetallic disc.
   4. Bronze Gate Valves: Class 125 NRS, bronze.
   5. Bronze Globe Valves: Class 125 nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 150.
   3. High Performance Butterfly Valves: Class 150, single flange.
   4. Iron Swing Check Valves: Class 125 , metal seats.
   5. Iron Gate Valves: Class 125 OS&Y.
   6. Iron Globe Valves: Class 125.

END OF SECTION 230523

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 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   4. 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

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. Vibration isolation equipment bases.
   17. Restrained isolation roof-curb rails.

B. Related Requirements:
   1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.

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 VIBRATION ISOLATION EQUIPMENT BASES

A. Source Limitations: Obtain vibration isolation equipment bases from single manufacturer.
B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails to have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
      a. Include supports for suction and discharge elbows for pumps.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
D. Concrete Inertia Base: field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
   1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
   2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases to have shape to accommodate supported equipment.
   3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
   4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.18 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.

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.

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.

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 Hydronic Piping Systems:
      a. Constant-flow hydronic systems.
      b. Variable-flow hydronic systems.
      c. Primary-secondary hydronic systems.
   3. Testing, adjusting, and balancing of equipment.
   4. Testing, adjusting, and balancing of existing HVAC systems and equipment.
   5. Procedures for exhaust hoods.
   6. 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 and pump curves.
   1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
   2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
H. Examine test reports specified in individual system and equipment Sections.
I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
L. Examine system pumps to ensure absence of entrained air in the suction piping.
M. Examine operating safety interlocks and controls on HVAC equipment.
N. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.
O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 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.

2. Hydronics:
   a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
   b. Piping is complete with terminals installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.
   f. Control valves are functioning in accordance with the sequence of operation.
   g. Shutoff and balance valves have been verified to be 100 percent open.
   h. Pumps are started and proper rotation is verified.
   i. Pump gauge connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
   j. Variable-frequency controllers' startup is complete and safeties are verified.
   k. Suitable access to balancing devices and equipment is provided.

3.4 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, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   2. Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.
   3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 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. Pumps.
   3. Fans and ventilators.
   4. Commercial kitchen hoods.

5. Boilers.
6. Furnaces.
7. Unit heaters.
8. Heat exchangers.
9. Condensing units.
10. Water chillers.
11. Energy-recovery units.
12. Air-handling units.
13. Heating and ventilating units.
14. Rooftop air-conditioning units.
15. Heating-only makeup air units.
16. Dedicated outdoor-air units.
17. Packaged air conditioners.
18. Split-system air conditioners.
19. Variable-refrigerant-flow systems.
20. Heat pumps.
21. Coils.
22. Fan coil units.
23. Dehumidification units.

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 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and equipment flow rates with pump design flow rate.
B. Prepare schematic diagrams of systems' Record drawings piping layouts.
C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check expansion tank for proper setting.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.
   5. Verify that motor controllers are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.
D. Measure and record upstream and downstream pressure of each piece of equipment.
E. Measure and record upstream and downstream pressure of pressure-reducing valves.
F. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
   1. Check settings and operation of each safety valve. Record settings.

3.10 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design flow.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gauge heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
   3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.
   1. Measure flow in main and branch pipes.
   2. Adjust main and branch balance valves for design flow.
   3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   1. Measure flow at terminals.
   2. Adjust each terminal to design flow.
   3. Re-measure each terminal after it is adjusted.
   4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:
   1. Measure differential pressure and verify that it is within manufacturer's specified range.
   2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:
   1. Measure and balance coils by either coil pressure drop or temperature method.
   2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.

G. Verify that memory stops have been set.

3.11 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:
   1. Verify that the pressure-differential sensor(s) is located as indicated.
   2. Determine whether there is diversity in the system.

C. For systems with no flow diversity:
   1. Adjust pumps to deliver total design flow.
      a. Measure total water flow.
         1) Position valves for full flow through coils.
         2) Measure flow by main flow meter, if installed.
         3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
      b. Measure pump TDH as follows:
         1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
         2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
         3) Convert pressure to head and correct for differences in gauge heights.
         4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
         5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
      c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
   2. Adjust flow-measuring devices installed in mains and branches to design water flows.
      a. Measure flow in main and branch pipes.
      b. Adjust main and branch balance valves for design flow.
      c. Re-measure each main and branch after all have been adjusted.
   3. Adjust flow-measuring devices installed at terminals for each space to design water flows.
      a. Measure flow at terminals.
      b. Adjust each terminal to design flow.
      c. Re-measure each terminal after it is adjusted.
      d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
      e. Perform temperature tests after flows have been balanced.
   4. For systems with pressure-independent valves at terminals:
      a. Measure differential pressure and verify that it is within manufacturer's specified range.
      b. Perform temperature tests after flows have been verified.
   5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system pressure-differential set point(s).
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:
   a. Re-measure and confirm that total flow is within design.
   b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
   c. Mark final settings.

D. For systems with flow diversity:
1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by Architect.
3. Adjust pumps to deliver total design flow.
   a. Measure total water flow.
      1) Position valves for full flow through coils.
      2) Measure flow by main flow meter, if installed.
      3) If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   b. Measure pump TDH as follows:
      1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      3) Convert pressure to head and correct for differences in gauge heights.
      4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      5) With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.
   c. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.
4. Adjust flow-measuring devices installed in mains and branches to design water flows.
   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.
   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.
6. For systems with pressure-independent valves at terminals:
   a. Measure differential pressure, and verify that it is within manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.
7. For systems without pressure-independent valves or flow-measuring devices at terminals:
   a. Measure and balance coils by either coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system pressure-differential set point(s).
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion, open discharge valve 100 percent, and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:
    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
    c. Mark final settings.

3.12 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.
B. Balance the secondary circuits after the primary circuits are complete.
C. Adjust pumps to deliver total design flow.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Measure flow by main flow meter, if installed.
      c. If main flow meter is not installed, determine flow by pump TDH or known equipment pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gauge heights.

d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve or speed until design water flow is achieved. If excessive throttling is required to achieve desired flow, recommend pump impellers be trimmed to reduce excess throttling.

3. Monitor motor performance during procedures, and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.
1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:
1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:
1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:
1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, speed, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.13 PROCEDURES FOR WATER-TO-WATER HEAT EXCHANGERS

A. Adjust and record water flow to within specified tolerances.
B. Measure and record inlet and outlet water temperatures.
C. Measure and record pressure drop.
D. Check and record settings and operation of safety and relief valves.

3.14 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.

3.15 PROCEDURES FOR WATER CHILLERS

A. Water-Cooled Chillers: Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow, with all pumps operating. With only one chiller operating in a multiple-chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
   1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
   2. Condenser-water entering and leaving temperatures, pressure drop, and water flow.
   3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
   4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
   5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
   6. Capacity: Calculate in tons of cooling.
   7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.

3.16 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.

3.17 PROCEDURES FOR BOILERS

A. Hydronic Boilers:
   1. Measure and record entering- and leaving-water temperatures.
   2. Measure and record water flow.
   3. Measure and record pressure drop.
   4. Record relief valve(s) pressure setting.
   5. Capacity: Calculate in Btu/h of heating output.
   6. Fuel Consumption: If boiler fuel supply is equipped with flow meter, measure and record consumption.
   7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
   8. Fan, motor, and motor controller operating data.

3.18 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each hydronic coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Entering and leaving refrigerant pressure and temperatures.

3.19 PROCEDURES FOR EXHAUST HOODS

A. Room Pressure: Measure and record room pressure with respect to atmosphere and adjacent space with hoods in room initially not operating and then with hoods operating.

B. Makeup Air: Systems supplying source of makeup air to hoods shall be in operation during testing and balancing of exhaust hoods.
   1. Measure and record temperature of makeup air entering hood. If hood makeup air is from multiple sources having different temperatures, measure and record the airflow and temperatures of each source and calculate the weighted average temperature.
   2. Use simulated smoke to observe supply air-distribution air patterns in vicinity of hoods. Consult with hood manufacturer and report conditions that have a detrimental effect on intended capture, containment, and other attributes effecting proper operation.

C. Rooms with Multiple Hoods: Test each hood separately, one at a time, and repeat tests with all hoods intended to operate simultaneously by design.

D. Canopy Hoods: Measure and record the following:
   1. Pressure drop across hood.
   2. Airflow by duct traverse where duct distribution will allow accurate measurement, and calculate hood average face velocity.
   3. Measure velocity across hood face and calculate hood airflow.
      a. Clearly indicate the direction of flow at each point of measurement.
      b. Measure velocity across opening on not less than 12-inch centers. Record velocity at each measurement, and calculate average velocity.
   4. Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

E. Kitchen Hoods:
   1. Type 1: Measure and record pressure drop and face velocity of hood filters and slots in accordance with hood manufacturer's instructions. Consult hood manufacturer to determine hood airflow using recorded information.
   2. Type 2: Measure and record airflow by duct traverse.

F. AHJ Tests: Conduct additional tests required by authorities having jurisdiction.

3.20 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.

3.21 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
   1. Measure and record the operating speed, airflow, and static pressure of each fan and equipment with fan(s).
   2. Measure and record flows, temperatures, and pressures of each piece of equipment in each hydronic system. Compare the values to design or nameplate information, where information is available.
   3. Measure motor voltage and amperage. Compare the values to motor nameplate information.
   4. Check the refrigerant charge.
   5. Check the condition of filters.
   6. Check the condition of coils.
   7. Check the operation of the drain pan and condensate-drain trap.
   8. Check bearings and other lubricated parts for proper lubrication.
   9. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. TAB After Construction: Before performing testing and balancing of renovated existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished in accordance with renovation scope indicated by Contract Documents. Verify the following:
   1. New filters are installed.
   2. Coils are clean and fins combed.
   3. Drain pans are clean.
   4. Fans are clean.
   5. Bearings and other parts are properly lubricated.
   6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.22 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
   2. Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm, within 10 cfm.
   3. Heating-Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.
   4. Chilled-Water Flow Rate: Plus or minus 10 percent. If design value is less than 10 gpm, within 10 percent.
   5. Condenser-Water Flow Rate: Plus or minus 10 percent.
B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.23 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.

3.24 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB specialist.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents, including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans performance forms, including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Heating coil, dry-bulb conditions.
      e. Face and bypass damper settings at coils.
      f. Fan drive settings, including settings and percentage of maximum pitch diameter.
      g. Variable-frequency controller settings for variable-air-volume systems.
      h. Settings for pressure controller(s).
      i. Other system operating conditions that affect performance.
   16. Test conditions for pump performance forms, including the following:
      a. Variable-frequency controller settings for variable-flow hydronic systems.
      b. Settings for pressure controller(s).
      c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water flow rates.

3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Balancing stations.
6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches, and bore.
      i. Center-to-center dimensions of sheave and amount of adjustments in inches.
      j. Number, make, and size of belts.
      k. Number, type, and size of filters.
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and speed.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches, and bore.
      f. Center-to-center dimensions of sheave and amount of adjustments in inches.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan speed.
      d. Inlet and discharge static pressure in inches wg.
      e. For each filter bank, filter static-pressure differential in inches wg.
      f. Preheat-coil static-pressure differential in inches wg.
      g. Cooling-coil static-pressure differential in inches wg.
      h. Heating-coil static-pressure differential in inches wg.
      i. List for each internal component with pressure-drop, static-pressure differential in inches wg.
      j. Outdoor airflow in cfm.
      k. Return airflow in cfm.
      l. Outdoor-air damper position.
      m. Return-air damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft..

h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Average face velocity in fpm.
   c. Air pressure drop in inches wg.
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
   e. Return-air, wet- and dry-bulb temperatures in deg F.
   f. Entering-air, wet- and dry-bulb temperatures in deg F.
   g. Leaving-air, wet- and dry-bulb temperatures in deg F.
   h. Water flow rate in gpm.
   i. Water pressure differential in feet of head or psig.
   j. Entering-water temperature in deg F.
   k. Leaving-water temperature in deg F.
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig.
   n. Refrigerant suction temperature in deg F.

G. 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, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
a. Heat output in Btu/h.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.
2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and speed.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.
g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan speed.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

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.
   2. Air-Terminal-Device Reports:
   3. 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..
   4. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Air velocity in fpm.
      c. Preliminary airflow rate as needed in cfm.
      d. Preliminary velocity as needed in fpm.
      e. Final airflow rate in cfm.
      f. Final velocity in fpm.
      g. Space temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model number and serial number.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.
      h. Required net positive suction head in feet of head or psig.
      i. Pump speed.
      j. Impeller diameter in inches.
      k. Motor make and frame size.
      l. Motor horsepower and rpm.
      m. Voltage at each connection.
      n. Amperage for each phase.

o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in gpm.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final suction pressure in feet of head or psig.
   h. Final total pressure in feet of head or psig.
   i. Final water flow rate in gpm.
   j. Voltage at each connection.
   k. Amperage for each phase.

L. Instrument Calibration Reports:
   1. Report Data:
      a. Instrument type and make.
      b. Serial number.
      c. Application.
      d. Dates of use.
      e. Dates of calibration.

3.25 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.

3.26 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.
      d. Polyisocyanurate.
   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.

J. Mineral Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.27 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. CertainTeed Corp.; CrimpWrap.
b. Johns Manville; MicroFlex.
c. Knauf Insulation; Pipe and Tank Insulation.

d. Manson Insulation Inc.; AK Flex.
e. Owens Corning; Fiberglas Pipe and Tank Insulation.

K. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal 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. Apache Products Company; ISO-25.
b. Dow Chemical Company (The); Trymer.
c. Duna USA Inc.; Corafoam.
d. Elliott Company; Elfoam.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
3. Flame spread index shall be 25 or less and smoke developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.

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).

F. Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
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-96.
b. Foster Products Corporation, H. B. Fuller Company; 81-33.
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 <Insert value> 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).

C. Joint Sealants:
1. Joint Sealants for Polyisocyanurate 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.
b. Foster Products Corporation, H. B. Fuller Company; 30-45.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.
f. Vimasco Corporation; 750.

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"f 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 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not overcompress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
   5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
   6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
   7. Stagger joints between insulation layers at least 3 inches.
   8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
   9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
   10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6 inch centers, starting at corners. Install 3/8 inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 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.

3.7 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.

3.8 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.

3.9 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.
C. Refer to details on drawings for exterior ductwork jacketing.

3.10 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.

3.11 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.
   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.
   7. Outdoor, exposed supply and return ductwork.
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.

3.12 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.

3.13 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
B. Exposed, rectangular, duct insulation shall be the following:
   1. Polyisocyanurate: 2-1/2 inches thick, R-12 minimum R-value.

3.14 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Dual-service heating and cooling pump insulation shall be the following:
   1. Polyisocyanurate: 1-1/2 inches thick.
   2. Flexible Elastomeric: 1-1/2 inches thick.

C. Dual-service heating and cooling expansion/compression tank and buffer tank insulation shall be one of the following:
   1. Flexible Elastomeric: 1-1/2 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1-1/2 inch thick.
   3. Polyisocyanurate: 1-1/2 inch thick.

D. Dual-service heating and cooling air-separator insulation shall be one of the following:
   1. Flexible Elastomeric: 1-1/2 inch thick.
   2. Mineral-Fiber Pipe and Tank: 1-1/2 inch thick.
   3. Polyisocyanurate: 1-1/2 inch thick.

3.15 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.

3.16 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Chilled Water and Brine, above 40 Deg F:
   1. NPS 12 and Smaller: Insulation shall be the following:
      a. Mineral Fiber, Preformed Pipe, Type I 1-1/2 inches thick.

C. Heating Hot Water Supply and Return, 200 Deg F and below:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Refrigerant Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1-1/2 inch thick.

E. Dual-Service Heating and Cooling, 40 to 200 Deg F:
   1. NPS 1-1/2 and Smaller: Insulation shall be the following:
      a. Mineral Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.
   2. NPS 2 and Larger: Insulation shall be the following:
      a. Mineral Fiber, Preformed Pipe, Type I: 2 inches thick.

3.17 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1-1/2 inches thick.

3.18 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".

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. Fan coil units and associated components.
2. Ductless split air conditioning system and associated components.
3. Modular water-cooled chiller and heat pump and all associated components.
4. Water distribution pumps and variable frequency drives.
5. Water source heat pump rooftop units and associated components.
6. Make-up air units and associated components.
7. Plate and frame heat exchanger and associated components.
8. Water treatment system and associated components.
9. Unit heaters and associated components.

10. Exhaust fan systems, hoods and associated components.
11. HVAC automatic temperature controls systems and sequences of operations.

END OF SECTION 230800

SECTION 230900 – INSTRUMENTATION AND CONTROL 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 CONTROL SYSTEM DESCRIPTION

A. The intent of this project is to have a Trane Tracer Building Automation System.
B. All controls products, control equipment, software, hardware, programming, graphics, wiring and conduit specified in this section shall be provided by Trane.
C. 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.
D. 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.
E. 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.
F. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.
G. Direct Digital Control (DDC) technology shall be used to provide the functions necessary for control of mechanical systems and equipment on this project.
H. The BAS manufacturer shall provide all hardware and software necessary to implement the functions and sequence of operations specified.

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Hydronic Piping
    1. Control Valves
    2. Flow Switches
    3. Temperature Sensor Wells and Sockets
    4. Hydronic Pressure Taps
    5. Hydronic Flow meters
B. Ductwork Accessories
    1. Automatic Dampers

1.4 APPROVED CONTROL SYSTEM MANUFACTURERS

A. Manufacturer: Subject to compliance with requirments, provide products by the following:
    1. Trane (Lauren Hayes 518-410-9375)

1.5 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.

1.6 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

1.7 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.

1.8 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.

1.9 SYSTEM MAINTENANCE

1. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).

2. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:

a. System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.

b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.

c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.

d. Database back-up

e. Operator coaching

3. Technician shall review critical alarm log and advise owner of additional services that may be required.
4. Technician shall provide a written report to owner after each inspection.

1.10 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
   iii. 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.
   iv. 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
      (a) 3-D Color Hydronic System Graphics with Animations
         (i) Example Animation: Pump Flashing when On
      (b) 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 controller 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. 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).

D. 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.

E. 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.

F. 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.

G. 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.

H. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment

I. 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.

J. 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.

K. 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.

L. 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.

M. 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. Verify that wires at control panels are tagged with their service designation and approved tagging system.

ii. 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.

C. Provide 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.

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.

3.5 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration: A complete demonstration of the capabilities of the BAS system shall be performed by the BAS manufacturer's field personnel. The BAS manufacturer shall dedicate a minimum of (16) hours on-site with the Owner representatives, and Engineer to demonstrate a complete functional test of all the BAS system requirements. This BAS demonstration shall constitute an acceptance inspection, and will represent the process of approving the BAS as designed and specified. Functional testing shall include, but is not limited to, the following system level components where installed:

B. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative.

3.6 TRAINING

A. Provide two training sessions of eight (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

3.3 DUCTLESS SPLIT SYSTEM AIR CONDITIONERS AND AIR-COOLED CONDENSING UNITS (AC-1/ACCU-1, AC-2/ACCU-2 AND AC-3/ACCU-3)

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 as required to maintain space set-point.

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.

3.4 SPLIT SYSTEM FAN COILS AND HEAT PUMP UNITS (FCU-A/HP-A, FCU-B/HP-B, FCU-C/HP-C AND FCU-D/HP-D)

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 as required to maintain space set-point.

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 occupied mode, the fan coil unit supply fan shall be on and run continuously. When the system is in the unoccupied mode, the fan coil unit supply fan shall be off.

3.5 TWO PIPE FAN COIL UNITS (FCU-1 through FCU-10)

A. Fan coil units are to be controlled by an application specific unitary DDC controller.

B. Unoccupied Operation: In the unoccupied mode, the supply fan shall be indexed off, the outside air damper shall modulate closed, the return air damper shall position open and the coil 3-way valve shall be modulated either closed (summer) or open (winter) based upon an adjustable outside air temperature. If the space temperature falls below the adjustable unoccupied heating set-point, the fan shall cycle on, the outside air damper shall remain closed and coil valve shall open. If the space temperature rises above the adjustable unoccupied cooling set-point and the outside air temperature is less than the space temperature, the fan shall be cycled on, the outside air damper shall be opened and the coil valve shall be closed. Upon a further call for unoccupied cooling the coil 3-way valve shall modulate open.

C. Morning Warm-up: When there is a call for heating and the zone temperature is two degrees off of set-point, a morning warm-up sequence shall be turned on, the outside air damper shall remain closed, the return air damper shall be full open and the coil valve shall open. When the zone reaches the heating set-point, the outside air damper shall go to minimum and the fan coil unit shall operate in the occupied mode.

D. Morning Cool-down: When a morning cool-down is initiated the unit shall operate in the airside-economizing mode, and fan shall be indexed on. If economizer mode is not

available, the outside air damper shall remain closed, the return air damper shall be full open and the coil valve shall open. When the zone temperature reaches the cooling set-point, the outside air damper shall go to minimum and the fan coil unit shall operate in the occupied mode.

E. Occupied Operation:
   1. When the fan coil unit is in the heating mode and the system has hot water, a call for heating shall open the outside air damper to minimum position for ventilation and modulate the coil 3-way valve to maintain the space temperature set point. When the fan coil unit is in the cooling mode and the system has chilled water, a call for cooling shall open the outside air damper to minimum position for ventilation and modulate the coil 3-way valve to maintain the space temperature set point.
   2. The fan coil unit fan shall run continuously, while in the occupied mode.

F. Low Temperature Thermostat (Freezestat): Shall be provided to protect the coil from freezing. When activated, the fan coil unit fan shall shutdown, outside air damper shall close, coil valve shall position to full open, and alarm shall be provided to the BMS. The set point for freezestat operation shall be adjustable. Reset shall be manual.

G. Discharge Air Limit Control: Provide an averaging type sensor in the discharge air stream arranged to override the temperature controls and prevent the discharge air temperature from dropping below 65° F (adjustable) and rising above 110°F (adjustable) during heating mode. Adjustments shall be made to outside air damper and coil valve to keep discharge air between limits.

H. Space Temperature Set-point: The space temperature heating/cooling set-point shall be programmable and adjustable at the BMS.

I. General:
   1. Provide a condensate overflow switch in the secondary drip pan that will open when the pan is full of condensate. The fan shall be shut-down, cooling shall be deactivated (for the affected unit) and an alarm shall be provided at the BMS.

3.6 KITCHEN HOOD EXHAUST FAN AND MAKE-UP AIR UNIT (EF-1/MUA-1, EF-2/MUA-2 AND EF-3/MUA-3)

A. The exhaust fan and make-up air unit operation shall be operated by a factory control panel mounted within the kitchen exhaust hood assembly. Whenever the hood panel is indexed on, the associated exhaust fan and the associated make-up air unit shall operate. The gas burner in the make-up air unit shall fire to maintain discharge air set-point. When the make-up air unit is on, the intake motorized damper shall be open. When the make-up air unit is off, the intake motorized damper shall be closed. Provide all controls, contacts, relays, switches, wiring, conduit, and etc. as required to tie the exhaust fan and make-up air unit operation to the exhaust hood operation.

B. General:
   1. Whenever the system is shut-down the outside air shall remain closed.
   2. Provide a low limit sensor in the unit discharge arranged to prevent winter discharge temperature from dropping below 50ºF (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 fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.7 KITCHEN HOOD EXHAUST FAN (EF-4 AND EF-5)

A. The exhaust fan operation shall be operated by a factory control panel mounted within the pizza exhaust hood assembly. Whenever the hood panel is indexed on, the exhaust fan shall operate. Whenever the hood panel is indexed off, the exhaust fan shall stop. Provide all controls, contacts, relays, switches, wiring, conduit, and etc. as required to tie the exhaust fan and make-up air unit operation to the exhaust hood operation.
B. Exhaust fan EF-4 shall be interlocked with RTU-25.
C. Exhaust fan EF-5 shall be interlocked with RTU-24.
D. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.8 DISHWASHER HOOD EXHAUST FAN (EF-6)

A. Exhaust fan shall operate when the dishwasher(s) is activated. Local controls within the dishwasher(s) assembly shall turn on/off the exhaust fan. When the fan turns on the motorized damper shall open. When the fan turns off the motorized damper shall close. Provide all controls, contacts, relays, switches, wiring, conduit, and etc. as required to tie the exhaust fan operation to the dishwasher(s) assembley operation.
B. Exhaust fan operation shall be interlocked with RTU-25.
C. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.9 GENERAL EXHAUST FANS (EF-7, EF-8 AND EF-12)

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 damper shall open and then the fan shall turn on. Whenever the exhaust fan is shut-down the associated motorized damper shall be closed.
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.

3.10 ELEVATOR SHAFT EXHAUST FAN (EF-9)

A. Elevator shaft exhaust fan shall be commanded on based on space temperature set-point. On a rise in space temperature above set-point the motorized damper associated with the exhaust fan shall open and then the exhaust fan shall turn on. The exhaust fan shall continue to run until space temperature falls below set-point, at which point the fan shall stop and the motorized damper shall close. Whenever the exhaust fan is shut-down the associated motorized damper shall be closed.
B. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.11 LASER ENGRAVER EXHAUST FANS (EF-10 AND EF-11)

A. A manual wall mounted switch with pilot light, located on wall by each laser engraver, shall turn the fan on and off. When the exhaust fan is commanded on: the motorized damper at the exhaust fan and in the transfer duct between the Laser Room and Pre-Engineering Lab shall open; and the motorized damper in the Pre-Engineering Lab exhaust duct shall close; and then the exhaust fan shall turn on. Whenever the exhaust fan is shut-down: the motorized damper at the exhaust fan and in the transfer

duct between the Laser Room and Pre-Engineering Lab shall close; and the motorized damper in the Pre-Engineering Lab exhaust duct shall open. If the exhaust fan does not turn an alarm shall be generated at the BMS and a local alarm audible/visual alarm shall be activated near the laser engraver.

B. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.12 KILN HOOD EXHAUST FANS (EF-13)

A. A manual wall mounted switch with pilot light, located on wall by the kiln hood, shall turn the fan on and off. When the exhaust fan is commanded on: the motorized damper at the exhaust fan and in the transfer duct between the Kiln Room and 3D Art & Ceramics shall open; and the motorized damper in the 3D Art & Ceramics exhaust duct shall close; and then the exhaust fan shall turn on. Whenever the exhaust fan is shut-down: the motorized damper at the exhaust fan and in the transfer duct between the Kiln Room and 3D Art & Ceramics shall close; and the motorized damper in the 3D Art & Ceramics exhaust duct shall open. If the exhaust fan does not turn an alarm shall be generated at the BMS and a local alarm audible/visual alarm shall be activated near the laser engraver.

B. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.13 RANGE HOOD EXHAUST FAN (EF-14)

A. A manual wall mounted switch with pilot light, located on wall near the exhaust hood, shall turn the fan on and off. When the exhaust fan is commanded on, the associated motorized damper located at the exhaust fan shall open and then the exhaust fan shall turn on. Whenever the exhaust fan is shut-down the associated motorized damper shall be closed. If the exhaust fan does not turn an alarm shall be generated at the BMS and a local alarm audible/visual alarm shall be activated near the exhaust hood.

B. Exhaust fan operation shall be interlocked with RTU-25.

C. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.14 PIZZA HOOD EXHAUST FAN (EF-15)

A. The exhaust fan operation shall be operated by a factory control panel mounted within the pizza exhaust hood assembly. Whenever the hood panel is indexed on, the exhaust fan shall operate. Whenever the hood panel is indexed off, the exhaust fan shall stop. Provide all controls, contacts, relays, switches, wiring, conduit, and etc. as required to tie the exhaust fan and make-up air unit operation to the exhaust hood operation.

B. Provide fan shut-down interlocked with the fire alarm system for exhaust fans greater than 1,000 CFM.

3.15 ELECTRIC HEATERS (UH-1 AND CUH)

A. Factory thermostat shall energize electric heating element as required to maintain space set-point. Whenever electric heating element is energized the unit fan shall be operational.

3.16 GEOTHERMAL PUMPS (P-1/P-1A)

A. Geothermal pumps shall be enabled on/off by the central plant heat pump controller or by any of the water source heat pump rooftop units.

B. The BMS shall select and alternate the lead and lag pump. The lead pump shall alternate to the lag pump after a programmable time period to accomplish equal hours of run time on each pump. If the lead pump fails an alarm shall be provided by the BMS and the lag pump shall be automatically activated in place of the scheduled lead pump.

C. A flow sensor at the pump set shall proof flow prior to heat pump operation and generate an alarm at the BMS in the event of a no flow condition. If flow is not established at the lead pump, the BMS shall switch to the lag pump.

D. Each pump shall be provided with a VFD for speed control arranged to vary pump output in response to load. Pump speed shall be controlled via the heat pump controller.

3.17 DUAL TEMPERATURE WATER PRIMARY PUMPS (P-2/P-2A)

A. The BMS shall sequence the lead primary pump on whenever the central plant heat pump system is making heating hot water or cooling chilled water. The lead pump shall run continuously and the stand-by pump shall remain off. Whenever the central plant is not operational the lead primary pump shall be shut-down.

B. The BMS shall select and alternate the lead and lag pump. The lead pump shall alternate to the lag pump after a programmable time period to accomplish equal hours of run time on each pump. If the lead pump fails an alarm shall be provided by the BMS and the lag pump shall be automatically activated in place of the scheduled lead pump.

3.18 DUAL TEMPERATURE WATER SECONDARY PUMPS (P-3/P-3A, P-4/P-4A & P-5/P-5A)

A. When chilled or hot water is available from the central plant heat pump system, the BMS shall sequence the lead pump on, when the outside air temperature rises above (summer) or below (winter) a programmable set-point (as sensed by an outdoor air temperature sensor/transmitter); the lead pump shall run continuously and the stand-by pump shall remain off. When the outside air temperature falls below (summer) or rises above (winter) the programmable set-point the lead pump shall shutdown.

B. The BMS shall select and alternate the lead and lag pump. The lead pump shall alternate to the lag pump after a programmable time period to accomplish equal hours of run time on each pump. If the lead pump fails an alarm shall be provided by the BMS and the lag pump shall be automatically activated in place of the scheduled lead pump.

C. Each pump shall be provided with a VFD for speed control arranged to vary pump output in response to load. Provide pressure sensors in the mains arranged to signal the VFD and vary pump speed. VFD shall modulate to maintain system differential pressure set-point. Differential set-point shall be determined in field during project commissioning phase.

3.19 DOAS ROOFTOP UNITS (RTU-1 THROUGH RTU-24)

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 and exhaust fans shall run continuously with the control circuit energized. The outside air damper shall open, the return

damper shall be full open and exhaust damper shall open. Provide a duct sensor in the supply fan discharge reset by a return air sensor (master/sub-master) arranged to modulate DX cooling and modulate hot gas reheat as required to maintain temperature and humidity set-point.

2. Winter Operation: Unit supply and exhaust fans will operate continuously with control circuits energized. The outside air intake and exhaust air dampers shall open with the return air damper open to the maximum position. The discharge air sensor shall modulate heatpump heating as required to maintain an adjustable discharge temperature set-point. For RTU-24 only, on a further call for heating, the gas fired furnace shall modulate as required to maintain 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, exhaust 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 exhaust 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 heatpump heating to maintain a setback temperature of 67º (adjustable). When operating in summer mode the system shall cycle the supply and exhaust fans and modulate DX cooling (unless economizer operation is available) to maintain a setback temperature of 80º (adjustable). During this cycle the outside air and exhaust 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 heatpump 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 modulate as required to achieve set-point. 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 50ºF (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.

3.20 CONSTANT VOLUME PACKAGED ROOFTOP UNIT (RTU-25)

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 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 modulate DX cooling and modulate hot gas reheat as required to maintain temperature and humidity set-point as required to maintain set-point.
   2. Winter Operation: Unit supply fan 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 fan and modulate gas heating to maintain a setback temperature of 67º (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 in stages as required to achieve set-point. 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 50ºF (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.

3.21 FINNED TUBE RADIATION (EXISTING)

A. In occupied mode the finned tube radiation shall work with associated VAV box to maintain space set-point. The 2-way control valve installed at the element shall modulate open/closed as required to maintain set-point.

B. In the unoccupied mode, the 2-way control valve installed on the finned tube radiation shall modulate open/closed as required to maintain night set-back set-point. Upon a further call for heating in unoccupied mode the associated HVAC system shall be energized.

3.22 CABINET UNIT HEATERS (EXISTING)

A. Provide a space sensor arranged to open and close the 2-way motorized zone valve as required to maintain occupied or unoccupied space set-point. The space sensor shall also cycle the unit fan on and off.

B. Provide a strap-on aquastat arranged to prevent the fan from cycling on when the water temperature drops below the aquastat setting.

3.23 AUDITORIUM CONSTANT VOLUME AIR HANDLER (EXISTING)

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 associated remote exhaust fan shall run continuously with the control circuit energized. The outside air dampers shall open to minimum position, the return damper shall be full open and relief damper (at the remote exhaust fan) shall be in minimum position. Provide a duct sensor in the supply fan discharge reset by a return air sensor (master-submaster) arranged to cycle the DX cooling coil and air cooled condensing unit in stages to maintain set-point.

2. Winter Operation: Unit supply fan and remote exhaust fan 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 the 3-way control valve for the hot water heating coil to maintain an adjustable discharge temperature set-point. On a drop in discharge air temperature below set-point the coil 3-way valve shall modulate open, the reverse shall occur when discharge air temperature increases above 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.

C. Unoccupied Cycle: When operating in winter mode and when the local finned tube radiation cannot maintain unoccupied set-points the system shall cycle the unit fans and open the heating coil valves for full flow through the coil to maintain a setback temperature of 55º (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 operate on 100% recirculation with the heating coil valves open during the warm-up periods programmed by the BMS. 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 during the cool-down periods programmed by the BMS. DX cooling shall cycle to maintain set-point. Upon reaching normal occupied space temperatures as determined through the return air sensor the system shall revert back to normal summer operation.

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. Three-way valve shall position to full flow through the coil.
2. Provide a low limit sensor in the unit discharge arranged to prevent winter discharge temperature from dropping below 60ºF (adjustable).
3. Provide a freeze protection thermostat in the unit heating coil plenum arranged to shut down the unit in the event air temperature drops below 35ºF. Thermostat shall be manual reset type.
4. Provide supply and return fan shut-down interlocked with the fire alarm system on systems greater than 1,000 CFM.
5. System larger than 2,000 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 ductwork 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.

3.24 BOILER PLANT (EXISTING)

A. Hot Water Boilers: The hot water boilers shall be enabled to operate under their on-board boiler controller by the BAS. The BAS shall enable each boiler on and off, in-sequence based on the hot water return water temperature. When enabled to operate the individual boiler controller shall enable the local boiler hot water circulator pump and control the boiler combustion air intake dampers. A flow switch shall be provided to proof flow. The BAS shall signal each boiler with a hot water set-point adjusted based on an outside air reset schedule.
   1. Main header supply and return water temperature shall be monitored by the BAS
   2. Running status and general alarm shall be monitored for each boiler
   3. Alarms available from each boiler controller shall be transmitted/wired into the BAS. All boiler controller points shall be fully integrated to the BAS.
   4. An open protocol interface/gateway shall be provided to each boiler control panel, for Modbus or BACnet MSTP.
   5. Common supply and return header temperature sensors shall be used to determine heating load. A control point for future flowmeter located in the main building heating hot water supply header shall be provided, as requested by the District.
   6. The internal boiler controls shall protect the boiler against low flow / no flow condition, low water condition, combustion air failure, flame failure, gas pressure limits, and other ASME CSD-1 safeties. Boiler alarms shall be annunciated locally and at the BAS. Where manual restarts are required, they shall be at the individual control devices within the boiler room, or at the individual boiler controller.

B. Boiler Room Combustion Air Damper: The boiler room combustion air damper shall open whenever the boilers or domestic water heater are started. The boiler room combustion air damper shall be wired to the boiler and water heater controllers through isolation relays, and an end switch on the boiler room combustion air damper. The end switch shall be hardwired and interlocked to the boiler and water heater controllers to prevent either from firing until the damper is opened.

C. Heating Control: At the beginning of the heating season, as defined by the heating system enable point being energized (manually by the operator or by program function (i.e., Time-Of-Day)), Siemens BAS shall enable the hot water plant to start. At the end of the heating season (heating system enable point is de-energized) the Siemens BAS shall disable the hot water boiler plant.

D. Boiler Pumps: Boiler circulator pumps shall be enabled on/off by the associated boiler's individual controller. A flow switch at each pump shall proof flow prior to boiler operation and generate an alarm at the BAS in the event of a no flow condition. If flow is not established at the lead boiler/pump combination, the BAS shall switch to the lag combination.

E. Heating Hot Water Distribution Pumps: The building heating hot water system consists of heating hot water distribution pumps with VFDs and differential pressure sensors. A building heating hot water flow meter shall be installed in the future as directed by the District.

1. The proper differential pressure set point shall be determined in the field during project the commissioning phase. The building heating hot water pump VFD shall modulate to maintain the system differential pressure set-point. Minimum and Maximum building heating hot water flowrates shall be adjustable through the VFD's, and shall be determined in the field.
2. The BAS shall utilize flow switches to confirm the lead building heating hot water pump is in the desired state (i.e. on or off) and generates an alarm if status deviates from BAS start/stop control. If the lead pump goes into alarm, the lag pump will automatically start.

F. Miscellaneous BAS Alarm Points and Monitoring:
1. Boiler Room Flood Alarm: The BAS shall monitor and alarm the water level in the existing boiler room sump. If the water level in the existing sump, reaches a high level, as sensed by a float or probe type device, an alarm shall be generated at the BAS.
2. Outside air temperature and humidity shall be monitored by the BAS.
3. The BAS shall monitor the emergency boiler/water heater shutdown circuit, and shall alarm at the BAS if the emergency shutdown circuit is activated.
4. Makeup water connection (both boiler and domestic water heater systems): A flow switch shall sense makeup water flow, and alarm at the BAS. Upon predetermined time period, the BAS shall activate an electric solenoid valve to shut off makeup water.

G. Domestic Hot Water System: The domestic hot water system consists of a high efficiency gas fired condensing package system with double wall indirect heat exchanger, pumps and controls, two domestic hot water storage tanks, two building domestic hot water recirculation pumps, and a central tempering valve.
1. The BAS shall monitor the building domestic hot water supply temperature via well type temperature sensor furnished by the BAS contractor and installed by the mechanical contractor.
2. The domestic water heater shall be enabled to operate under its on-board controller by the BAS. The BAS shall enable the domestic water heater on and off, based on building occupancy schedule, as determined by the District. When enabled to operate, the domestic water heater controller shall enable the internal circulator pump, heater, and control the water heater combustion air intake damper. A flow switch shall be provided to prove flow.
3. Running status and alarms available from the water heater controller shall be transmitted/wired into the BAS. All domestic water heater controller points shall be fully integrated to the BAS.
4. An open protocol interface/gateway shall be provided for the water heater control panel, for Modbus or BACnet MSTP.
5. A control point for future flowmeter to be located in the main building domestic water service near the existing water meter shall be provided, as requested by the District.
6. The internal water heater controls shall protect the water heater against low flow / no flow condition, low water condition, combustion air failure, flame failure, gas pressure limits, and other ASME CSD-1 safeties. Water heater alarms shall be annunciated locally and at the BAS. Where manual restarts are required, they shall be at the individual control devices within the boiler room, or at the individual water heater controller.

H. Domestic Hot Water Recirculation Pumps: The domestic hot water system has two individual recirculation pumps. The BAS shall monitor pump status, and shall enable the recirculation pumps based on building occupancy schedule, as determined by the District. In addition, an aquastat wired in series with the pump enable circuit, shall shutdown recirculation pump when DHWR temp reaches aquastat setpoint. Flow switches shall be used to confirm recirculation pump operation, pump failure shall be alarmed at the BAS.

I. Domestic Hot Water Storage Tanks: Domestic Water Storage tank temperature shall be monitored and alarmed by the BAS. Alarm points shall be high temp and low temp, with adjustable setpoints for each.

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.

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.

B. Natural Gas System Pressure within Buildings: 0.5 psig or less.

C. Natural Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

D. 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.

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.

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.

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.

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.

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.

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. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
B. 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.
C. 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.
D. 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.

E. 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.

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. 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.

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.

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.

3.5 VALVE INSTALLATION

A. Install manual gas shutoff valve for each piece of gas equipment.
B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

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.

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.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 23 Section, "Identification for HVAC Piping and Equipment" for piping and valve identification.

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.

3.13 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. Hot water heating piping.
   2. Chilled water piping.
   3. Dual-temperature heating and cooling water piping.
   4. Geothermal water piping.
   5. Makeup water piping.
   6. Condensate-drain piping.
   7. Blowdown-drain piping.
   8. Air vent piping.
   9. Safety valve inlet and outlet piping.

B. Related Sections include the following:
   1. Division 23 Section, “Hydronic Pumps” for pumps, motors, and accessories for hydronic piping.

1.3 SUBMITTALS

A. Product Data: For each type of the following:
   1. Plastic pipe and fittings with solvent cement.
   2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   3. Air control devices.
   4. Chemical treatment.
   5. Hydronic specialties.

B. Shop Drawings: Detail, at 1/4 scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding certificates.

D. Qualification Data: For Installer.

E. Field quality control test reports.

F. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

G. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site, initial system water quality, and the final water quality in the piping system after completion of cleaning, flushing and filling.

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 STEEL PIPE AND FITTINGS
A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
B. Cast Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
C. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
D. Cast Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
F. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

2.3 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.

2.4 JOINING MATERIALS
A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast iron and steel flanges.
B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

E. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
F. 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).
G. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 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.

2.6 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 Flanges:
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. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Factory-fabricated companion-flange assembly, for 150- or 300 psig minimum working pressure as required to suit system pressures.

E. Dielectric-Flange Kits:
1. 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. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
2. Companion flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
3. Separate companion flanges and steel bolts and nuts shall have 150- or 300 psig minimum working pressure where required to suit system pressures.

F. 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.

G. 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.

2.7 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23 Section, "General Duty Valves for HVAC Piping."

B. Automatic Temperature Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section, "Instrumentation and Control for HVAC."

C. Bronze, Calibrated Orifice, Balancing Valves:
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. Armstrong Pumps, Inc.
b. Bell & Gossett Domestic Pump; a division of ITT Industries.
c. Taco.
2. Body: Bronze, ball or plug type with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.
4. Plug: Resin.
5. Seat: PTFE.
6. End Connections: Threaded or solder.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

D. Cast Iron or Steel, Calibrated Orifice, Balancing Valves:
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. Armstrong Pumps, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Taco.
2. Body: Cast iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:
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. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

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. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Spence Engineering Company, Inc.
   f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: Stainless steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

2.8 AIR CONTROL DEVICES

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. Amtrol, Inc.
   2. Armstrong Pumps, Inc.
   3. Bell & Gossett Domestic Pump; a division of ITT Industries.
   4. Taco.

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/8.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   3. Operator: Noncorrosive metal float.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/4.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 240 deg F.

2.9 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40 mesh startup strainer, and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

B. Stainless Steel, Braided, Flexible Connectors:
1. Body: Corrugated hose and braid 300 series stainless steel.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Expansion fittings are specified in Division 23 Section, "Expansion Fittings and Loops for HVAC Piping."

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot, Chilled, Dual Temperature, and Geothermal Water piping, aboveground, NPS 3 and smaller, shall be either of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
2. Schedule 40 steel pipe; Class 125, cast iron fittings; cast iron flanges and flange fittings; and threaded joints.

B. Hot, Chilled, Dual Temperature, Geothermal Water piping, aboveground, NPS 4 and larger, shall be the following:
1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Makeup water piping installed aboveground shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. 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.

E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

F. Air-Vent Piping:
1. Inlet: Same as service where installed.
2. Outlet: Type L, drawn-temper copper tubing with soldered joints.

G. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.2 VALVE APPLICATIONS

A. Install calibrated orifice, balancing valves in the return pipe of each heating or cooling terminal.

B. Install safety valves at hot water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

C. Install pressure-reducing valves at makeup water connection to regulate system fill pressure.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves according to Division 23 Section, "General Duty Valves for HVAC Piping."
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section, "Expansion Fittings and Loops for HVAC Piping."
U. Identify piping as specified in Division 23 Section, "Identification for HVAC Piping and Equipment."
V. 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."
W. 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."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section, "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
   3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
   4. Spring hangers to support vertical runs.
   5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
   6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
   8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
   9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
   1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
   2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
   3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. 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.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

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

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
I. Plastic Piping Solvent-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.

3.6 HYDRONIC SPECIALTIES INSTALLATION
A. Install manual air vents at high points in piping, at heat transfer coils, and elsewhere as required for system air venting.
B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat transfer coils and elsewhere as required for air venting.

3.7 TERMINAL EQUIPMENT CONNECTIONS
A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
B. Install control valves in accessible locations close to connected equipment.
C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 23 Section, "Meters and Gages for HVAC Piping."

3.8 CHEMICAL TREATMENT AND PIPE CLEANING
A. Perform an initial analysis of system water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling. After cleaning, flushing and chemical additions the following quality standards must be met.
   1. pH: 7.0 to 9.0.
   2. "P" Alkalinity: 100 to 500 ppm.
   3. Reserve alkalinity: Not less than 5 ppm.
   4. Total Suspended Solids: Less than 10 ppm and filtered for maximum 600 micron size.
   5. Total Hardness: Less than 350 PPM.
   6. Biological Counts: < 1000 cfu’s.
   7. Iron: <1.0.
B. New piping systems shall be cleaned independently prior to connection.

1. Be sure that all system piping is open and receives good circulation during the cleaning process. All unit coils should be open and receive flow during the cleaning process.
2. Provide a temporary 5 micron particulate size filtration system for use during the cleaning process.
3. Flush low point drains, expansion tanks, control valves, and etc. while circulating to help remove any debris that has been dislodged.
4. Flush with constant circulation until the water is relatively clear. If necessary, partially drain the system before adding the cleaning products.
5. Use CHEM-AQUA 655T or similar, at a rate of 2.5 gallons per 1,000 gallons system volume. The system pH must be maintained between 7.0 and 8.0 during the cleaning process.
6. If required, apply antifoam, use CHEM-AQUA FC-101 PLUS or similar, at 4 to 16 ounces per 1,000 gallons.
7. Immediately fill the system back to normal operating level and circulate for 12 to 24 hours at ambient temperature.
8. When cleaning times are complete, open high point vent(s) and drain the system completely. Refill the system with fresh water and circulate to mix. If the system has an automatic fill valve, initiate a heavy bleed and flush the system until the water is clear and free of foam. The by-pass around the pressure reducing valve can be open to permit more flow. The pressure relief valve will prevent over-pressurizing the system. Be sure to not bleed the system faster than makeup water is added to prevent air from entering the system. If flushing is not practical, the system should be repeatedly drained and filled until the water is clear.
9. System should be flushed until the phosphate level is less than 10 ppm.
    a. Once target phosphate level is reached, add the recommended amount of inhibited glycol. Failure to add inhibitor could result in red water problems due to corrosion.

C. Add initial chemical treatment to achieve water quality levels noted in this article. The system water must be tested and adjusted. pH can be adjusted down by making a solution of CHEM-AQUA BP-600 powder in water and adding to the system slowly to lower the pH within the specified range.
D. Submit all water quality tests as part of the close-out documentation.
E. Refer to drawing for additional notes.

3.9 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and determine that hydronic system is full of water.
   4. Test piping in accordance with the International Mechanical Code.
   5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
   6. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   4. Set temperature controls so all coils are calling for full flow.
   5. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC 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. Hydronic specialty valves.
   2. Air vents.
   3. Expansion tanks and fittings.
   4. Air/dirt separators and purgers.
   5. Strainers.
   6. Flexible connectors.

B. Related Requirements:
   1. Section 230511 "Common Work Results for HVAC".
   2. Section 230516 "Expansion Fittings and Loops for HVAC Piping".
   3. Section 230523 "General Duty for HVAC Piping".
   4. Section 232123 "Hydronic Pumps".
   5. Section 232513 “Water Treatment for Closed-Loop Hydronic Systems”.
   6. Section 236423 “Modular Scroll Chillers”.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:
   1. Include construction details and material descriptions for hydronic piping specialties.
   2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators in accordance with ASME BPVC, Section IX.

B. Pressure-relief and safety-relief valves and pressure vessels bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME BPVC, Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, butterfly, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass- and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gauge Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Low inlet-pressure check valve.
7. Inlet Strainer: Stainless steel, removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size and Capacity: As indicated on Drawings.
10. Operating Pressure: Factory set and field adjustable.

D. Diaphragm-Operated Pressure-Relief Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Brass.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPDM.
6. Valve Seat and Stem: Noncorrosive.
7. Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC, Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Combination Assemblies: Include bronze or brass-alloy ball valve.
3. Identification Tag: Marked with zone identification, valve number, and flow rate.
4. Size and Capacity: For each application, provide a valve with rated capacity equal to or greater than capacity of device being served.
5. Performance: Maintain constant flow within plus or minus 10 percent, regardless of system pressure fluctuations.
6. Minimum CWP Rating: 175 psig.
7. Maximum Operating Temperature: 200 deg F.

2.2 AIR VENTS

A. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.3 EXPANSION TANKS AND FITTINGS

A. Bladder-Type ASME Expansion Tanks:
1. Tank: Welded steel, rated for 125 psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled in accordance with ASME BPVC, Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity. Field-replaceable bladder.
3. Sight glass.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.4 AIR/DIRT SEPARATORS AND PURGERS

A. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125 psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.5 STRAINERS

A. Y-Pattern Strainers:
1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless steel, 40-mesh strainer, or perforated stainless steel basket.

4. CWP Rating: 125 psig.

2.6 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:
   1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
   2. End Connections: Threaded or flanged to match equipment connected.
   3. Performance: Capable of 3/4-inch misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.
B. Spherical, Rubber, Flexible Connectors:
   1. Body: Fiber-reinforced rubber body.
   2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   3. Performance: Capable of misalignment.
   4. CWP Rating: 150 psig.
   5. Maximum Operating Temperature: 250 deg F.

2.7 BUFFER TANK

A. Flanged horizontal buffer tank:
   1. Designed and constructed per ASME Code Section VIII, Division 1.
   2. Construction: Carbon steel with exterior red oxide primer finish.
   3. Maximum design pressure and temperature 125 PSI at 375 degrees F.
   4. Flanged inlet and outlet.
   5. Registered with the National Board of Pressure Vessel Manufacturers.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine all piping specialties 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. Examine threads on all devices for form and cleanliness.
C. 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.
D. Do not attempt to repair defective piping specialties; replace with new devices. Remove defective piping specialties from site.

3.2 INSTALLATION OF VALVES

A. Install calibrated-orifice balancing valve at each branch connection to return main.
B. Install calibrated-orifice, balancing valve in the return pipe of each heating or cooling terminal.
C. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
D. Install pressure-relief and safety-relief valves at hot-water generators and elsewhere as required by ASME BPVC. Pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC, Section VIII, Division 1, for installation requirements.

3.3 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve full size of separator outlet; extend full size to nearest floor drain.

D. Install diaphragm- or bladder-type expansion tanks on the floor.

E. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 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. Close-coupled, in-line centrifugal pumps.
   2. Separately coupled, base-mounted, end-suction centrifugal pumps.
   3. Separately coupled, base-mounted, double-suction centrifugal pumps.
   4. Automatic condensate pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.
B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.
C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
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 230800, COMMISSIONING OF HVAC SYSTEMS.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section, "Product Requirements."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. UL Compliance: Comply with UL 778 for motor operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect

flanges, pipe openings, and nozzles with wooden flange covers or with screwed in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Available Manufacturers:

1. Armstrong Pumps Inc.
2. Bell & Gossett; Div. of ITT Industries.
3. PACO Pumps.
4. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically. Rate pump for 175 psig minimum working pressure and a continuous water temperature of 225 deg F. Pumps shall be capable of being serviced without disturbing piping connections.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and flanged end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
3. Pump Shaft: Steel, with bronze shaft sleeve.
4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
5. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Shall meet scheduled horsepower, speed, voltage and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications. Refer to pump schedules for additional motor requirements.

E. Capacities and Characteristics:
   1. Refer to schedules on drawings.

2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Available Manufacturers:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett; Div. of ITT Industries.
   3. PACO Pumps.
   4. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, long coupled, single stage, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175 psig minimum working pressure and a continuous water temperature of 225 deg F. Pumps shall have a foot mounted volute to allow removal and service of the entire rotating assembly without disturbing the pump piping, electrical motor connections or pump to motor alignment.

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
   2. Impeller: Cast stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.
   3. Pump Shaft: Steel, with stainless steel shaft sleeve.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless steel spring, and Buna-N bellows and gasket.
   5. Pump Bearings: Grease-lubricated ball bearings contained in cast iron housing with grease fittings.

D. Not all manufacturers provide drop-out coupling that allows removal and replacement of impeller without disconnecting piping. This device is required with volute support described above.

E. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Flexible couplings shall be center drop-out type to allow disassembly and removal without removing pump shaft or motor. Neoprene coupling sleeve for variable-speed applications.

F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

G. Base Plate: Shall be of structural steel or fabricated steel channel configuration fully enclosed at sides and ends, with securely welded cross members and fully open grouting area (for field grouting). The minimum base plate stiffness shall conform to ANSI/HI 1.3.8.2.1-2009 for grouted Horizontal Baseplate Design Standards.

H. Permanently lubricated ball bearings are available up through 5 hp. Larger motors have grease-lubricated ball bearings.
I. Motor: Shall meet scheduled horsepower, speed, voltage and enclosure design. Pump and motors shall be factory aligned, and shall be realigned after installation. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications. Refer to pump schedules for additional motor requirements.
J. If Project has more than one pump, delete paragraph and subparagraphs below and schedule pumps on Drawings.
K. Capacities and Characteristics:
    1. Refer to schedules on drawings.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

A. Available Manufacturers:
    1. Armstrong Pumps Inc.
    2. Bell & Gossett; Div. of ITT Industries.
    3. PACO Pumps.
    4. Taco, Inc.
B. Source Limitations: Obtain pumps from a single source from single manufacturer.
C. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
D. Pump Construction:
    1. Casing: Horizontally split, cast iron, with replaceable bronze wear rings, threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 125 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.
    2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, and keyed to shaft. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
    3. Pump Shaft: Type 420 stainless steel.
    4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket.
    5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.
F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
    1. Enclosure: Totally enclosed, fan cooled.
    2. NEMA Premium Efficient motors as defined in NEMA MG 1.

3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Variable-speed motor.

I. Capacities and Characteristics:
1. Refer to schedules on drawings.

2.5 AUTOMATIC CONDENSATE PUMPS

A. Available Manufacturers:
1. Little Giant Pump Company.
2. Approved Equal.

B. Source Limitations: Obtain pumps from a single source from single manufacturer.

C. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Collects and removes condensate from fan coil units, air handling units, condensing boilers, and similar components. Include factory- or field-installed check valve and 72-inch minimum, electrical power cord with plug.

D. Capacities and Characteristics:
1. Refer to schedules on drawings.

2.6 PUMP SPECIALTY FITTINGS

A. Triple-Duty Valve: Angle or straight pattern, 175 psig pressure rating, cast iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement.

B. Suction Diffuser: Angle pattern, 175 psig pressure rating, cast iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless steel permanent strainers; bronze or stainless steel straightening vanes; drain plug; and factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Vibration isolation devices are specified in Division 23 Section, "Vibration

and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section, "Hangers and Supports for HVAC Piping and Equipment."

E. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
   1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.3 ALIGNMENT

A. Perform alignment service. When required by manufacturer to maintain warranty coverage, engage a factory-authorized service representative to perform it.
B. Comply with pump and coupling manufacturers' written instructions.
C. Comply with requirements in HI standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
E. Refer to pump details on drawings for pump specialties.
F. Install electrical connections for power, controls, and devices.

3.5 STARTUP SERVICE

A. 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. 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.
   5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
   6. Start motor.

7. Open discharge valve slowly.

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 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.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section, "Demonstration and Training."

END OF SECTION 232123

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-410A:
   1. Suction Lines for Air Conditioning Applications: 300 psig.
   2. Suction Lines for Heat Pump Applications: 535 psig.
   3. Hot Gas and Liquid Lines: 535 psig.

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.

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-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

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.
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 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC 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. Water treatment for closed-loop hydronic systems.
   2. Manual chemical-feed equipment.
   3. Chemicals.
   4. Inhibited ethylene glycol and propylene glycol.

B. Related Requirements:
   1. Section 232113 “Hydronic Piping” for chemical treatment and pipe cleaning.

1.3 DEFINITIONS

A. RO: Reverse osmosis.

B. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.

C. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
   1. Bypass feeders.
   2. Water meters.
   3. Inhibitor injection timers.
   4. pH controllers.
   5. Chemical solution tanks.
   6. Injection pumps.
   7. Chemical-treatment test equipment.
   8. Chemical material safety data sheets.
   9. Inhibited propylene glycol.

B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.
   1. Include plans, elevations, sections, and attachment details.
   2. Include diagrams for power, signal, and control wiring.

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.

1.5 INFORMATIONAL SUBMITTALS

A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
B. Field quality-control reports.
C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
D. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

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. Aqua-Chem, Inc.
   2. Earthwise Environmental Inc.
   3. Metro Group, Inc. (The).
   4. Nalco; an Ecolab company.
   5. Suez Water Technologies (Formerly GE Water).

2.2 PERFORMANCE REQUIREMENTS

A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
C. Closed hydronic systems, including dual-temperature water shall have the following water qualities:
   1. pH: Maintain a value within 7.0 to 9.0.
   2. Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Steel Corrosion Inhibiters: Provide sufficient inhibitors to limit mild steel corrosion.
   4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion.

5. Scale Control: Provide softened water for initial fill and makeup. Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Provide steel feeders with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
   1. Capacity: 12 gallons.
   2. Minimum Working Pressure: 125 psig.

2.4 CHEMICAL-TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, corrosion inhibitors, alkalinity, hardness, and other properties recommended by manufacturer.

2.5 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

2.6 INHIBITED PROPYLENE GLYCOL

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. Dynalene.
   2. Fremont Industries.
   3. Houghton Chemical Corp.
   4. The Dow Chemical Company.

B. Inhibited Propylene Glycol:
   1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon steel, brass, copper, stainless steel, and cast-iron piping and fittings.
   2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
   3. pH value shall be maintained between 6.0 to 8.5, with reserve alkalinity greater than 5 ppm.
   4. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
   5. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified by the manufacturer to provide freeze protection to minus 20 deg F. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
   6. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.
B. Install water-testing equipment on wall near water-chemical-application equipment.
C. Install interconnecting control wiring for chemical-treatment controls and sensors.
D. Mount sensors and injectors in piping circuits.
E. Bypass Feeders: Install in closed hydronic systems, including dual-temperature water, and glycol water, and equip with the following:
    1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
    2. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
    3. Install a swing check on the inlet after the isolation valve.
F. Install automatic fluid make-up equipment for glycol water system, and include the following:
    1. Chemical solution tanks.
    2. Chemical solution injection pumps.
    3. Water meter in makeup supply to system.
    4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

3.3 PIPING CONNECTIONS

A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to equipment, allow space for service and maintenance.
C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General Duty Valves for HVAC Piping".
E. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

3.4 ELECTRICAL CONNECTIONS

A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:
   1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
   7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
   8. Repair leaks and defects with new materials, and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Comply with ASTM D3370 and with the following standards:
   1. Silica: ASTM D859.
   2. Acidity and Alkalinity: ASTM D1067.
   3. Iron: ASTM D1068.
   4. Water Hardness: ASTM D1126.

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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

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 232513

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. Double-wall round ducts and fittings.
   4. Sheet metal materials.
   5. Duct liner.
   6. Sealants and gaskets.
   7. 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 DOUBLE-WALL ROUND DUCTS 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. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.

B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   1. 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."
   2. 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."
   3. 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."

C. Inner Duct: Minimum 0.028-inch solid sheet steel.

D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Coat insulation with antimicrobial coating.
   4. Cover insulation with polyester film complying with UL 181, Class 1.

E. Refer to notes on drawings for more information.

2.4 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.

2.5 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.

2.6 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.

2.7 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.
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 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT
A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.
B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches (38 mm) from bottom of duct.
C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 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."

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section, "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows.
   1. Kitchen cooking exhaust hood and kitchen dishwasher exhaust hood ductwork shall be minimum 18 gauge stainless steel.
   2. 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 Shop Exhaust Hood:
   a. Welded seams and joints.
   b. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
   c. SMACNA Leakage Class: 3.
5. 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 inch thick. Duct liner not required for exhaust ductwork serving fume hoods, laser engravers commercial kitchen hoods.

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, "Digital, Addressable Fire-Alarm System" 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.

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. Utility set fans.
   2. Centrifugal roof ventilators.
   3. In-line centrifugal fans.

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 Submittal: For 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.

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.

1.5 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.

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 vibration isolation and wind restraints.

C. Wind-Restraint Performance:
   1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Greenheck
   2. Carnes Company.
   3. Loren Cook Company.
   4. PennBarry.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast iron or cast steel hub and spun steel inlet cone, with hub keyed to shaft.
   1. Blade Materials: Steel or Aluminum.
   2. Blade Type: Backward inclined, Forward curved, Airfoil.
   3. Spark Resistant Construction: AMCA 99, Type C.

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L50 of 200,000 hours, L10 of 80,000 hours.

F. Extend grease fitting to accessible location outside of unit.

G. Belt Drives:
   1. Factory mounted, with final alignment and belt adjustment made after installation
   2. Service Factor Based on Fan Motor Size: 1.2.
   3. In "Motor Pulleys" Subparagraph below, the 5-hp limit is standard with many manufacturers but is a designer's choice.
   4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   6. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

H. Additional Construction Requirements:
   1. Refer to schedules on drawings for additional construction requirements for utility set fans.

I. Accessories:
   1. Refer to schedules on drawings.

J. Capacities and Characteristics:
   1. Refer to schedules on drawings.

2.3 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.

2.4 IN-LINE CENTRIFUGAL FANS

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. Carnes Company.
2. Greenheck Fan Corporation.
3. Loren Cook Company.
4. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
1. Refer to schedules on drawings.

G. Capacities and Characteristics:
1. Refer to schedules on drawings.

2.5 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.

2.6 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 233433.13 - COMMERCIAL AIR CURTAINS

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: Commercial air-curtain unit.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air curtain units.
   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.

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.

1.4 INFORMATIONAL SUBMITTALS

A. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtain units to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish one set of filters for each unit installed.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of air curtain units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period (Nonheating Units): 60 months.
   2. Warranty Period (Electric Heating Units): 24 months.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics:

1. Refer to schedules on drawings for more information.

2.2 COMMERCIAL AIR-CURTAIN UNIT

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. Berner Air Curtains
   2. Approved equal.
B. Source Limitations: Obtain air curtain from single source from single manufacturer.
C. Housing:
   1. Galvanized Steel: Galvanized steel with electrostatically applied, epoxy-enamel, powder-coat finish.
D. Mounting Brackets: Galvanized steel, for wall mounting.
E. Air-Intake Grilles:
   1. Grilles: Integral to, and same material as, housing.
F. Fans:
   1. Centrifugal, forward curved, double width, double inlet.
   2. Galvanized steel, Painted steel, or Aluminum.
   3. Statically and dynamically balanced.
   4. Direct drive.
G. Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
   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. Single speed or Multispeed.
   3. Resiliently mounted.
   4. Continuous duty.
   5. Totally enclosed, air over.
   6. Integral thermal-overload protection.
   7. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
   8. Disconnect: Lockable disconnect.
H. Electric-Resistance Coils:
   1. Coil Assembly: Comply with UL 1995.
   2. Frame: Galvanized-steel frame.
   3. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.
   4. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or unit.
      a. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
   5. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
      a. Magnetic contactor.
      b. Step controller.
      c. Time-delay relay.

d. Pilot lights; one per step.
e. Airflow-proving switch.

I. Filters:
1. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in cardboard frame.
2. Washable Panel Filters: Removable, aluminum, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch-thick, stainless steel filter frame.
3. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

J. Controls:
1. Thermostat: Built-in; line voltage, factory installed and wired to junction box on air curtain.
2. Automatic Door Switch: Roller type ,Combination roller-plunger type, Plunger type, or Magnetic, installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.
3. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.
4. Three-Speed Switch: Manually activates, deactivates, and controls air-curtain fan speed.
5. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.
6. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 1 enclosure with door-mounted, HAND-OFF-AUTO switch.

K. Accessories:
1. Mounting Brackets: Adjustable mounting brackets for wall mounting.

2.3 SOURCE QUALITY CONTROL

A. Source Quality Control: Test to 300 and 200 psig underwater.
B. Testing: Test and inspect steam coils in accordance with ASHRAE 33.
C. AMCA Certification for Fan Aerodynamic Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 211.
D. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label, air curtain units in accordance with AMCA 311.
E. Comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine work areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install air curtains with clearance for equipment service and maintenance.

B. Equipment Installation: Install air curtains. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
C. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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 CONTROL CONNECTIONS
A. Install control and electrical power wiring to field-mounted control devices.

3.5 ADJUSTING
A. Adjust motor speed to achieve specified airflow.
B. Adjust discharge louver and dampers to regulate airflow.
C. Adjust air-directional vanes.

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. Perform tests and inspections with the assistance of a factory-authorized service representative.
C. Tests and Inspections:
1. After installing air curtains completely, perform visual and mechanical check of individual components.
2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
D. Air-curtain unit will be considered defective if it does not pass tests and inspections.
E. Prepare test and inspection reports.

3.7 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.

3.8 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.

3.9 DEMONSTRATION

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

END OF SECTION 233433.13

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. Round ceiling diffusers.
   3. Linear bar diffusers.
   4. Linear slot diffusers.
   5. Adjustable bar registers and grilles.
   6. Fixed face registers and grilles.

B. Related Sections:
   1. Division 23 Section, "Air Duct Accessories" for fire 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:
   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.

B. Round Ceiling Diffuser:
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. METALAIRE, Inc.
e. Nailor Industries Inc.
f. Price Industries.
g. Titus.
h. Tuttle & Bailey.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel.
4. Finish: Baked enamel, color selected by Architect.
5. Pattern: Fully adjustable.
6. Dampers: Radial opposed blade, unless otherwise noted on drawings.

2.2 LINEAR OUTLETS / INLETS

A. Linear Bar Diffuser:
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: Aluminum.
4. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
5. Frame: 3/4 inch wide.
6. Mounting: Refer to drawings.
7. Damper Type: Cable operated adjustable opposed-blade assembly.

B. Linear Slot Diffuser:
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 - Shell: Aluminum.
4. Material - Pattern Controller and Tees: Aluminum.
5. Finish - Face and Shell: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
6. Finish - Pattern Controller: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
7. Finish - Tees: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
8. Slot Width: 1-1/2 inches.
9. Number of Slots: Two.
10. Length: Refer to drawings.
11. Accessories: Refer to drawings.

2.3 REGISTERS AND GRILLES

A. Fixed Face Registers and Grilles:
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. 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.

B. Adjustable Bar Register:
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: Steel.
3. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.
4. Face Blade Arrangement: Horizontal to long dimension spaced 3/4 inch apart.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Damper Type: Adjustable opposed blade.

C. Eggcrate Registers:
1. Manufacturers:
   a. Titus.
   b. Carnes.
   c. Price.
   d. Nailor.
2. Type: Fixed register of 1/2 inch louvers. Free area of at least 90%.
3. Fabrication: Aluminum border and core with factory baked enamel, white finish. Border width 1-1/4 inch with counter sunk screw holes.
4. Damper: Opposed blade volume damper.
5. Finish: Color selected by architect from manufacturer's full range of standard and custom colors/finishes.

2.4 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.

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 235700 - HEAT EXCHANGERS 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. Gasketed-plate heat exchangers.

1.3 DEFINITIONS

A. TEMA: Tubular Exchanger Manufacturers Association.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
   2. Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

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.

1.5 INFORMATIONAL SUBMITTALS

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

B. Product Certificates: For each type of shell-and-tube heat exchanger. Documentation that shell-and-tube heat exchangers comply with "TEMA Standards."

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:

a. Structural failures, including heat exchanger, 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. Plate Heat Exchangers:
      1) Gasketed-Plate Type; One year(s).

PART 2 - PRODUCTS

2.1 GASKETED-PLATE HEAT EXCHANGERS

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. Alfa Laval Inc.
   2. Armstrong Fluid Technology.
   3. Bell & Gossett; a Xylem brand.
   4. Kelvion, Inc.
   5. Taco Comfort Solutions.

B. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.

C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.

D. Frame:
   1. Capacity to accommodate 20 percent additional plates.
   2. Painted carbon steel with provisions for anchoring to support.

E. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.
   1. Fabricate attachment of heat-exchanger support bars and guide bars with reinforcement strong enough to resist heat-exchanger movement during seismic event when heat-exchanger support bars and guide bars are anchored to building structure.

F. End-Plate Material: Painted carbon steel.

G. Tie Rods and Nuts: Steel or stainless steel.

H. Plate Material: 0.024 inch thick before stamping; Type 304 stainless steel.

I. Gasket Materials: Glue free Nitrile rubber.

J. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
   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.

K. Enclose plates in solid aluminum or stainless steel removable shroud.

L. Capacities and Characteristics:
   1. Refer to equipment schedule on drawings.

2.2 ACCESSORIES

A. Shroud: Aluminum or Steel sheet.

B. Miscellaneous Components for High-Temperature, Hot-Water Unit: Control valve, valves, thermometers, and piping.
C. Pressure-Relief Valves: Cast iron,, ASME rated and stamped.
   1. Pressure-relief valve setting: To be determined based adjacent equipment set-points.

2.3 SOURCE QUALITY CONTROL
A. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.
B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
C. Heat exchangers will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
B. Examine roughing-in for heat-exchanger piping to verify actual locations of piping connections before equipment installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF HEAT EXCHANGER, GENERAL
A. Equipment Mounting:
   1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Install floor-mounted and wall-hung steam heat exchangers at sufficient height, using sufficient length supports, to achieve required steam and condensate pipe pitch. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

3.3 INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER
A. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base, and fasten legs to base.
B. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufacturer's written instructions.

3.4 PIPING CONNECTIONS
A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
D. Install shutoff valves at heat-exchanger inlet and outlet connections.

E. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.
F. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.
G. Pipe pressure-relief valves, full size of valve connection, to floor drain.
H. Install hose end valve to drain shell.
I. Install thermometer on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 230511 "Common Work Results for HVAC."
J. Install pressure gauges on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for pressure gauges specified in Section 230511 "Common Work Results for HVAC."

3.5 CLEANING
A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.
C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Heat exchanger will be considered defective if it does not pass tests and inspections.
D. Prepare test and inspection reports.

3.7 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.

3.8 DEMONSTRATION
A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

3.9 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 235700

SECTION 236423 - MODULAR SCROLL CHILLERS

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 SECTION INCLUDES

A. Modular Dual Scroll Chillers and Heat Recovery Chillers
B. Header Rack piping
C. Controls and Supervisory controls

1.3 REFERENCES

A. AHRI 550/590-2011 - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle.
B. AHRI 700-2012 - Specification for Fluorocarbon Refrigerants.
C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.
E. ANSI/ASHRAE 135 - BACnet-2001.
F. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code.
G. ANSI/NEMA MG 1 - Motors and Generators.
H. ANSI/NFPA 70 - National Electric Code.
I. ANSI/UL 1995 - Heating and Cooling Equipment.
J. International Mechanical Code - 2012 - Chapter 11: Refrigeration.
K. USGBC - Leadership in Energy and Environmental Design (LEED) Rating System.

1.4 SUBMITTALS

A. Submit manufacturer’s specifications for Chillers showing dimensions, weights, capacities, performance ratings, electrical characteristics, gauges and finishes of materials and installation instructions. This information should also include:
   1. Wiring diagrams
   2. Electrical requirements
   3. Field piping and wiring connections
   4. Control diagrams and specifications
   5. Rated capacities
   6. Accessories
   7. Warranty information
   8. A factory test report will completed for each module and available upon request
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 230800, COMMISSIONING OF HVAC.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
   1. Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
      - Structural supports.
      - Piping roughing-in requirements.
      - Wiring roughing-in requirements, including spaces reserved for

electrical equipment.
- Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section, and elevation views, drawn to ½" to 1-foot scale.

B. Certificates: For certification required in "Quality Assurance" Article

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
B. Instructional Videos: Including those that are prerecorded, when available.

1.9 REGULATORY REQUIREMENTS

A. ASHRAE 15 for safety code for mechanical refrigeration.
B. ASHRAE 147 for refrigerant leaks, recovery, and handling and storage requirements.
C. ASHRAE 90.1 – minimum Energy Efficiency compliance for water-to-water heat pumps.
D. Comply with NFPA 70 or National Electric Code (N.E.C)
E. Comply with UL 1995 and be nationally recognized with ETL
F. Tested in accordance with ARI 550

1.10 DELIVERY, STORAGE AND HANDLING

A. Ship water chillers from factory fully charged with refrigerant and filled with oil.

1.11 WARRANTY

A. Provide one (1) year parts warranty from startup date. Include coverage for complete modular chiller package as manufactured and delivered to site. The warranty also comes with a 30 day from startup labor and refrigerant warranty.
- Provide five (5) year compressor warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE 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. Waterfurnace.
2. MultiStack
3. ClimaCool
4. Approved equal.

2.2 MODULAR HEAT RECOVERY CHILLER PACKAGE

A. Factory-assembled with compressor, compressor motor, compressor motor controller, evaporator, condenser, controls, dryers (on each circuit), interconnecting unit piping and wiring, and indicated accessories. Fabricate Chiller mounting base with reinforcement strong enough to resist Chiller movement during a seismic event when Chiller is anchored to field support structure. Field removable (4 Pipe/6 Pipe) piping rack complete with 3 way modulating water valves, 2 way modulating and manual on/off water valves, factory mounted temperature sensors, and factory mounted water flow switches with quick disconnecting electrical plug for control wiring

connections between the compressor section and the piping rack section.

B. Each Module shall be self-contained. This means a module can be completely removed from a bank of modules without getting into the system. Each module will connect to the header assembly independently, have independent electrical connection, and be capable of running in a temperature control mode with or without a building automation system.
C. Failure of any module in a bank will not affect the operation of any other module. Any circuit failure on a single module shall not affect the operation of the circuit.
D. Each module shall be capable of supplying chilled water, hot water, or simultaneously producing both.

2.3 SCROLL COMPRESSORS

A. Hermetically sealed, scroll compressors with factory charged POE or PVE oil and R-454B refrigerant.
B. Suction gas cooled motors operate at 3500 rpm protected by internal overload device.
C. Compressors can be operated separately to provide staged capacity for lighter load conditions.
D. Factory mounted with rubber isolation grommets.
E. Acoustically insulated sound blankets are factory installed around the compressor to reduce sound emanating from the compressor.
F. Oil Management: Built in oil management and three stage oil separation system.

2.4 EVAPORATOR

A. The water to refrigerant heat exchangers shall be single circuit water, copper-brazed 316 stainless steel channel plates, capable of withstanding 650 psig working pressure on the refrigerant side and 360 psig on the water side. Refrigerant circuits are separate with a common water supply. This provides optimal part load efficiency compared to using two single circuit heat exchangers. Heat exchangers are designed to work as an evaporator and condenser.
B. Heat exchangers are covered with 3/4” closed-cell insulation.
C. Water line connections attached to the heat exchangers have integrated paddle flow switches for proving flow before and during operation. The water line connections will also have isolation valves to isolate the individual heat exchanger without interrupting system operation for service and maintenance.
D. Heat exchanger will have a 2.5” flanged connection for direct building connection or to a factory header rack configuration.
E. Heat exchangers shall be designed, tested, and stamped in accordance with UL 1995.

2.5 CONDENSER

A. The water to refrigerant heat exchangers shall be dual circuit, copper-brazed 316 stainless steel channel plates, capable of withstanding 650 psig working pressure on the refrigerant side and 360 psig on the water side. Refrigerant circuits are separate with a common water supply. This provides optimal part load efficiency compared to using two single circuit heat exchangers. Heat exchangers are designed to work as an evaporator and condenser.
B. Heat exchangers are covered with 3/4” closed-cell insulation.
C. Water line connections attached to the heat exchangers have integrated paddle flow switches for proving flow before and during operation. The water line connections will also have isolation valves to isolate the individual heat exchanger without interrupting system operation for service and maintenance.
D. Heat exchanger will have a 2.5” flanged connection for direct building connection or

to a factory header rack configuration.

E. Heat exchangers shall be designed, tested, and stamped in accordance with UL 1995.

2.6 REFRIGERATION CIRCUIT

A. Refrigerant Compatibility: Chiller parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
B. Refrigerant Type: Unit shall utilize refrigerant type R-454B.
C. Unit shall be provided with factory installed electronic expansion valve (EEV) on each circuit (2/unit in total).
D. Unit shall have check valve in discharge gas outlet to prevent refrigerant back flow during shutdown.
E. Unit shall have refrigeration filter drier that is adequately sized for the circuit charge requirements
F. Each circuit shall have suction and discharge pressure transducers that monitor the current pressures.
G. Each circuit shall contain an electric solenoid refrigerant reversing valve for heat pump operation.

2.7 OPTIONAL SOUND KIT

A. Chiller compressor compartment is completely enclosed with 16ga sheet metal and covered with closed cell foam insulation with a thickness of 0.75”.

2.8 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.
B. Single-point power connection to terminal block in a NEMA 1 control panel per module for complete redundancy.
C. Breaker rotary-type thru door disconnect in control panel of each module.
D. Each compressor should have: Fuse protection, Contactor, thermal overload, along with motor phase and temperature protection.
E. High pressure cut outs set at 550 PSIG with manual reset.
F. Low pressure cut outs set at 80 PSIG with manual reset.

2.9 Waterside Piping

A. Four Pipe Standard
    1. Header assembly shall be independent of the chiller module for installation and service. The header assembly should be isolatable from the module without interrupting the functionality of other modules.
    2. Each module shall use its isolation valves to prevent flow from going through modules that are not currently in operation.

2.10 Module Controls

A. The unit shall be controlled using a microprocessor which sequences all functions and modes of operations.
B. Units shall be capable to communicate thru standard DDC protocols such as Open N2, Lon or BACnet (MS/TP @ 19,200 Baud Rate).
C. Standalone, non-communicating units are also available that will operate with thermostat, mechanical, or electronic signals. Temperature set mode is capable of controlling to leaving load temperature.
D. Inputs from the DDC or from the interface
    1. Enable
    2. Operating Mode

3. Hot water Set point
4. Cold Water Set point

E. Outputs to the DDC and points displayed on interface
1. Entering and leaving water temperatures on each heat exchanger
2. Suction and discharge pressures on each circuit
3. Suction and Discharge saturation temperatures
4. Evaporator and condenser liquid line temperatures on each circuit
5. Superheat and subcooling on each circuit
6. Compressor amperage
7. Compressor runtime
8. Compressor status
9. Isolation valve status

F. Software resetting safeties
1. Low Saturation alarm
2. High Saturation alarm
3. No flow condenser
4. No flow evaporator
5. No charge alarm
6. Minimum runtime
7. Minimum off time

G. Manual Reset Alarms
1. High pressure
2. Low pressure
3. Thermal overload
4. Motor protect

2.11 Optional Supervisor controls

A. The supervisory panel staging logic uses a specialized PID control algorithm that is designed to control stepped capacity systems and will be responsible for staging all the compressors in a chiller back from the required BAS inputs.
1. BAS inputs
a. Enable
b. Mode
c. Hot Water set point
d. Cold Water set point

B. The Supervisory Control Panel(SCP) is scalable from two to ten dual scroll modular chillers depending on the configuration

C. The supervisory controller can be programmed for communications to virtually any type of BAS. BACnet and LonWorks® are standard options for the supervisor's BAS connection. The BAS will connect a single point of communication to the master panel for the modular chiller bank.

D. Peripheral devices such as pumps and other chiller plant equipment can—on a custom basis—be added to the control of the supervisor.

E. All staging criteria can be adjusted from the interface for specific system tuning if necessary.

2.12 ACCESSORIES

A. Strainers
1. Each header inlet will be supplied a 30 mesh why type strainer that connects between the chiller bank and building connection. Integrated strainers in each module will not be allowed.

B. Temperature headers

1. Pre-engineered temperature headers will be supplied by the manufacture to be installed on the inlet and outlet header between the modular bank and the building connection. These temperature sensors shall be used for staging a bank of modular chillers.

C. Bypass Valves
1. The bank of chiller modules will utilize a pre-engineered bypass and temperature assembly. These bypass assemblies will be supplied by the chiller manufacture and installed between the chiller outlet connections and the building connection. The bypass assembled will be controller by the supervisory controller to prevent dead heading of pumps.
2. A system bypass may still be needed to maintain minimum system or minimum pump flows. These bypasses will be supplied, controlled, and installed by others.

2.13 CAPACITIES AND CHARACTERISTICS
A. Refer to equipment schedule on drawings.

2.14 SOURCE QUALITY CONTROL
A. Perform functional test of water chillers before shipping.
B. Factory test and inspect evaporator and water-cooled condenser according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
C. For water chillers located indoors, rate sound power level according to AHRI 575 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Upon receiving equipment check for any sign of shipping damage.
B. Final locations of the chillers on the Drawings are approximate, unless dimensioned. Determine exact locations before roughing-in piping and electrical work.
C. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Comply with requirements for piping specified in Division 23 Section "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Install piping adjacent to chiller to allow service and maintenance.
C. Connect each chiller drain connection with a union and drain pipe, and extend pipe to floor drain.
D. A strainer must be installed before the inlet of the chiller bank that is a minimum of 30 mesh.
E. The Master control requires an independent 120v electrical feed.
F. The Master panel shall have a single back net mstp wire ran to the chiller bank, and then daisy chained between the modules.
G. A buffer tank must be installed if the system volume does not meet the manufactures system requirements.
H. Coordinate sizes and locations of bases with actual equipment to be installed. Cast

anchor-bolt inserts into concrete bases.

I. Equipment Mounting:
   1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
J. Maintain manufacturer's recommended clearances for service and maintenance.
K. Maintain clearances required by governing code.
L. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
M. Install separate devices furnished by manufacturer and not factory installed.
   1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Where installing piping adjacent to chillers, allow space for service and maintenance.
C. Evaporator Fluid Connections:
   1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
   2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage and drain connection with valve.
   3. Make connections to water chiller with a union, flange, or mechanical coupling.
D. Condenser Fluid Connections:
   1. Connect to condenser inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
   2. Connect to condenser outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve.
   3. Make connections to water chiller with a union, flange, or mechanical coupling.
E. Connect each drain connection with a drain valve, full size of drain connection. Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.
F. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring between chillers and other equipment to interlock operation as required for a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC System for remote monitoring and control of chillers. Comply with requirements in Section 230900 “Instrumentation and Control for HVAC”.

3.6 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.
B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations and connections.
C. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
D. Complete installation and startup checks according to manufacturer’s written instructions and perform the following:
    1. Verify that refrigerant charge is sufficient and chiller has been leak tested.
    2. Verify that pumps are installed and functional.
    3. Verify that thermometers and gages are installed
    4. Operate chiller for run-in period
    5. Check bearing lubrication and oil levels
    6. For chillers installed indoors, verify that refrigerant pressure relief device is vented outdoors.
    7. Verify proper motor rotation.
    8. Verify static deflection of vibration isolators, including deflection during chiller startup and shutdown.
    9. Verify and record performance of fluid flow and low temperature interlocks for evaporator and condenser.
    10. Verify and record performance of chiller protection devices.
    11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
    12. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assembly, installation, and connection.
E. Prepare test and inspection startup reports.
F. 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.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.
    1. Instructor shall be factory trained and certified.
    2. Provide not less than two 4-hour training sessions.
    3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
    4. Where available, provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
    5. Obtain Owner sign-off that training is complete.
    6. Owner training shall be held at Project site.

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 236423

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.

1.2 SUMMARY

A. This Section includes packaged, outdoor, central-station air handling units (rooftop units) with the following components and accessories:
   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 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 vibration isolation and wind restraints.
C. Wind-Restraint Performance:
1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Daikin Applied.
2. Carrier Corporation.
3. Johnson Controls.
4. Trane.

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 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.

2.10 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.

2.11 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.

2.12 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.

2.13 ACCESSORIES

A. Refer to schedules on drawings.

2.14 ROOF CURBS

A. 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.

B. Curb Height: 24 inches.

2.15 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. Perform tests and inspections and prepare test reports.
B. Tests and Inspections:
   1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to furnace combustion chamber.
   3. Inspect for visible damage to compressor, coils, and fans.
   4. Inspect internal insulation.
   5. Verify that labels are clearly visible.
   6. Verify that clearances have been provided for servicing.
   7. Verify that controls are connected and operable.
   8. Verify that filters are installed.
   9. Clean condenser coil and inspect for construction debris.
   10. Clean furnace flue and inspect for construction debris.
   11. Connect and purge gas line.
   12. Remove packing from vibration isolators.
   13. Inspect operation of barometric relief dampers.
   14. Verify lubrication on fan and motor bearings.
   15. Inspect fan wheel rotation for movement in correct direction without vibration and binding.
   16. Adjust fan belts to proper alignment and tension.
   17. Start unit according to manufacturer's written instructions.
      a. Start refrigeration system.
      b. Do not operate below recommended low ambient temperature.
      c. Complete startup sheets and attach copy with Contractor's startup report.
   18. Inspect and record performance of interlocks and protective devices; verify sequences.
   19. Operate unit for an initial period as recommended or required by manufacturer.
   20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
      a. Measure gas pressure on manifold.
      b. Inspect operation of power vents.
      c. Measure combustion air temperature at inlet to combustion chamber.

d. Measure flue gas temperature at furnace discharge.
e. Perform flue gas analysis. Measure and record flue gas carbon dioxide and oxygen concentration.
f. Measure supply air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Adjust and inspect high temperature limits.
22. Inspect outdoor air dampers for proper stroke and interlock with return air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
25. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor air intake.
26. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

C. 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. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. 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 237413

SECTION 237423.13 - PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR 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. Packaged, direct-fired, outdoor, heating-only makeup-air units.

1.3 ACTION SUBMITTALS

A. Product Data: For each outdoor, direct, gas-fired heating-only, makeup air unit.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   3. Include unit dimensions and weight.
   4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
   5. Fans:
      a. Include certified fan-performance curves with system operating conditions indicated.
      b. Include certified fan-sound power ratings.
      c. Include fan construction and accessories.
      d. Include motor ratings, electrical characteristics, and motor accessories.
   6. Include filters with performance characteristics.
   7. Include direct, gas-fired burners with performance characteristics.
   8. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each outdoor, direct, gas-fired, heating-only, makeup air unit.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of gas-fired heating and ventilating units, as well as procedures and diagrams.
   4. Include diagrams for power, signal, and control wiring.

C. Delegated Design Submittal: For vibration isolation 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. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

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 230800, COMMISSIONING OF HVAC.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
B. Sample Warranty: For manufacturer's warranty.
C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
   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.
D. Startup service reports.
E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For direct, gas-fired, heating-only, makeup air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set(s) for each unit.
   2. Gaskets: One set(s) for each access door.
   3. Fan Belts: One set(s) for each unit.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of direct-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Entire Unit: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.
   2. Warranty Period for Burners: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, 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 Startup."
C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to equipment schedule on drawings.

2.3 PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. CaptiveAire Systems.
   2. Greenheck Fan Corporation.
   3. REZNOR, a brand of Nortek Global HVAC.

B. Unit Casings:
   1. General Fabrication Requirements for Casings:
      a. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
      b. Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.
      c. Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
   2. Configuration: Horizontal unit with horizontal or bottom discharge for roof-mounting installation.
   3. Double-Wall Construction:
      a. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick, with manufacturer's standard finish.
      b. Inside Casing Wall:
         1) Inside Casing, Burner Section: Galvanized steel, solid, minimum 14-gauge- thick steel.
         2) Inside Casing, All Other Sections: Galvanized steel solid or perforated steel.
      c. Floor Plate: Galvanized steel, minimum 18 gauge thick.
      d. Casing Insulation:
         1) Materials: Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071.
         2) Casing Panel R-Value: Minimum R-6.
         3) Insulation Thickness: 1 inch.
         4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
      e. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
   4. Panels and Doors:
      a. Panels:
         1) Fabrication: Formed and reinforced, with same materials and insulation thickness as casing.
         2) Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.

3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

b. Doors:
1) Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
3) Gasket: Neoprene, applied around entire perimeters of panel frames.
4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

c. Locations and Applications:
1) Fan Section: Doors and inspection and access panels.
2) Access Section: Doors.
3) Gas-Fired Burner Section: Doors.
4) Damper Section: Doors.
5) Filter Section: Doors large enough to allow periodic removal and installation of filters.
6) Mixing Section: Doors.

d. Service Light: 100-W vaporproof fixture with switched junction box located inside adjacent to door.
1) Locations: Each section accessed with door.

C. Outdoor-Air Intake Hood:
1. Type: Manufacturer's standard hood or louver.
2. Materials: Match cabinet.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Filter: Aluminum, 2 inches cleanable.
5. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

D. Roof Curbs:
1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
1) Materials: ASTM C1071, Type I or Type II.
2) Thickness: 1-1/2 inches.
b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
1) Liner Adhesive: Comply with ASTM C916, Type I.
2) 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.
3) 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.
2. Curb Height: 24 inches.

E. Fans, Drives, and Motors:
   1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
   2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.
      a. Shafts: With field-adjustable alignment.
      b. Shaft Bearings: Heavy-duty, self-aligning, permanently lubricated ball bearings with an L50 rated life of 100,000 hours according to ABMA 9.
      c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
      d. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
      e. Shaft Lubrication Lines: Extended to a location outside the casing.
      f. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.
         1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
   3. Drives: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
      a. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
      b. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
      c. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
   4. Motors:
      a. Motor Sizes: Maximum sizes as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
      b. Enclosure: Open, dripproof.
      c. Efficiency: Premium efficient as defined in NEMA MG 1.
      d. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
   5. Air Filtration:
   6. Panel Filters:
      a. Description: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.
      b. Filter Unit Class: UL 900.
      c. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
      d. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
   7. Side-Access Filter Mounting Frames:

a. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Galvanized steel track.
   1) Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

F. Dampers:
1. Outdoor-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg rated in accordance with AMCA 500D.
2. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
3. Electronic Damper Operators:
   a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   b. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
   c. Operator Motors:
      1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230511 "Common Work Results for HVAC."
      2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
      3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf.
   f. Size dampers for running torque calculated as follows:
      1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
      2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
      3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
      4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
      5) Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
      6) Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
   g. Coupling: V-bolt and V-shaped, toothed cradle.

h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
j. Power Requirements (Two-Position Spring Return): 24 V dc or 120 V ac.
k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
m. Temperature Rating: Minus 22 to plus 122 deg F.
n. Run Time: 12 seconds open, 5 seconds closed.

G. Direct-Fired Gas Burner:
1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
2. CSA Approval: Designed and certified by and bearing label of CSA.
3. Burners: Stainless steel.
a. Rated Minimum Turndown Ratio: 30 to 1.
b. Fuel: Natural gas.
c. Ignition: Electronically controlled electric spark with flame sensor.
d. Gas Control Valve: Modulating.
e. Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, electronic-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
f. High-Altitude Model Kit: For Project elevations more than 2000 feet above sea level.
4. Safety Controls:
a. Owner's insurance underwriter may require gas train by FM Global or another insurer. Verify with Owner.
b. Gas Manifold: Safety switches and controls complying with ANSI standards and FM Global.
c. Vent Flow Verification: Differential pressure switch to verify open vent or Flame rollout switch.
d. High Limit: Thermal switch or fuse to stop burner.
e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
f. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.
g. Control Transformer: 24 V ac.

H. Unit Control Panel:
1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
2. Control Panel: Surface-mounted remote panel, with engraved plastic cover and the following lights and switches:
a. On-off-auto fan switch.
b. Heat-vent-off switch.
c. Supply-fan operation indicating light.
d. Heating operation indicating light.
e. Thermostat.
f. Damper position potentiometer.

g. Dirty-filter indicating light operated by unit-mounted differential pressure switch.
h. Safety-lockout indicating light.
i. Enclosure: NEMA 250, Type 3R.

I. Controls:
1. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls" for control equipment and sequence of operation.
2. Control Devices:
a. Remote Thermostat: Adjustable room thermostat with temperature readout.
b. Remote Setback Thermostat: Adjustable room thermostat without temperature readout.
c. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
d. Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature.
e. Timers, Seven Day:
1) Programming-switch timer with synchronous-timing motor and seven-day dial.
2) Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.
3) Multiple-switch trippers.
4) Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
f. Timers, Solid State:
1) Programmable time control with four separate programs.
2) 24-hour battery carryover.
3) Individual on-off-auto switches for each program.
4) 365-day calendar with 20 programmable holidays.
5) Choice of fail-safe operation for each program.
6) System fault alarm.
g. Ionization-Type Smoke Detectors:
1) 24-V dc, nominal.
2) Self-restoring.
3) Plug-in arrangement.
4) Integral visual-indicating light.
5) Sensitivity that can be tested and adjusted in place after installation.
6) Integral addressable module.
7) Remote controllability.
8) Responsive to both visible and invisible products of combustion.
9) Self-compensating for changes in environmental conditions.
3. Fan Control, Interlocked: Fan to start with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
4. Fan Control, Timer: Timer starts and stops direct-fired heating and ventilating unit and exhaust fan(s).
5. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.
6. Temperature Control:

a. Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.
b. Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor with temperature adjustment, and adjustment on remote-control panel.
c. Timer shall select remote setback thermostat to maintain space temperature at 50 deg F.
d. Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.
e. Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

7. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.
   a. Hardwired Points:
      1) Room temperature.
      2) Discharge-air temperature.
      3) Burner operating.
   b. ASHRAE 135.1 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

J. Accessories:
1. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
2. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

2.4 MATERIALS

A. Steel:
1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:
1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of piping and electrical connections before equipment installation.

C. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, DIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

A. Roof Curb: Turn over to the general contractor who shall install.
B. Install gas-fired units according to NFPA 54, "National Fuel Gas Code."
C. Install controls and equipment shipped by manufacturer for field installation with direct-fired heating and ventilating units.

3.3 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.
B. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.
C. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.

3.4 DUCT CONNECTIONS

A. Duct Connections: Connect supply ducts to direct-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.

3.5 ELECTRICAL CONNECTIONS

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

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Inspect for visible damage to burner combustion chamber.
   2. Inspect casing insulation for integrity, moisture content, and adhesion.
   3. Verify that clearances have been provided for servicing.

4. Verify that controls are connected and operable.
5. Verify that filters are installed.
6. Purge gas line.
7. Inspect and adjust vibration isolators.
8. Verify bearing lubrication.
9. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
10. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions.
1. Complete startup sheets and attach copy with Contractor's startup report.
2. Inspect and record performance of interlocks and protective devices; verify sequences.
3. Operate unit for run-in period recommended by manufacturer.
4. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
5. Calibrate thermostats.
6. Adjust and inspect high-temperature limits.
7. Inspect dampers, if any, for proper stroke and interlock with return-air dampers.
8. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
9. Measure and record airflow. Plot fan volumes on fan curve.
10. Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

    a. High-limit heat.
    b. Alarms.
11. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
12. Verify drain-pan performance.
13. Verify outdoor-air damper operation.

D. 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 ADJUSTING

A. Adjust initial temperature set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing makeup air unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt

and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.
B. Units will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.11 DEMONSTRATION

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

3.12 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 237423.13

SECTION 237433 - PACKAGED, OUTDOOR, HEATING AND COOLING MAKEUP 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.

1.2 SUMMARY

A. This Section includes cooling-only and heating rooftop replacement-air units.

1.3 DEFINITIONS

A. DDC: Direct-digital controls.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, and location and size of each field connection. Prepare the following by or under the supervision of a qualified professional engineer:

1. Design Calculations: For selecting and designing restrained vibration isolation roof-curb rails.
2. Mounting Details: For securing and flashing roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Rooftop replacement-air units to roof-curb mounting 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. Size and location of rooftop replacement-air unit mounting rails and anchor points and methods for anchoring units to roof curb.
2. Required roof penetrations for ducts, pipes, and electrical raceways, including size and location of each penetration.

D. Startup service reports.

E. Operation and Maintenance Data: For rooftop replacement-air units 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 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. Product Options: Drawings indicate size, profiles, and dimensional requirements of rooftop replacement-air units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 COORDINATION

A. Coordinate size, installation, and structural capacity of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

B. Coordinate size, location, and installation of rooftop replacement-air unit manufacturer's roof curbs and equipment supports with roof Installer.
1. Coordinate installation of restrained vibration isolation roof-curb rails, which are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components listed below that fail in materials or workmanship within specified warranty period.
1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fan Belts: One set for each belt-driven fan.

2. Filters: One set for each unit.

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 vibration isolation and wind restraints.

C. Wind-Restraint Performance:

1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 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. AAON, Inc.
2. Addison Products Company.
3. Des Champs Laboratories, Incorporated.
4. LCSystems.
5. Reznor-Thomas & Betts Corporation; Mechanical Products Division.
6. CaptiveAire**.**

2.3 CABINET

A. Construction: Double wall.

B. Exterior Casing: Galvanized steel with baked-enamel paint finish and with lifting lugs and knockouts for electrical and piping connections.

C. Interior Casing: Galvanized steel.

D. Base Rails: Galvanized-steel rails for mounting on roof curb.

E. Service Doors: Hinged access doors with neoprene gaskets.

F. Internal Insulation: Fibrous-glass duct lining complying with ASTM C 1071, Type II.

1. Thickness: 1 inch.
2. Insulation Adhesive: Comply with ASTM C 916, Type I.
3. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

G. Condensate Drain Pans: Formed sections of galvanized-steel sheet designed for self-drainage. Fabricate pans and drain connection to comply with ASHRAE 62.1-2004.

H. Roof Curb: Full-perimeter curb of sheet metal, minimum 24 inches high, with wood nailer, neoprene sealing strip, and welded Z-bar flashing.

I. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.4 SUPPLY-AIR FAN

A. Fan: Forward-curved centrifugal; statically and dynamically balanced, galvanized steel, mounted on solid-steel shaft with self-aligning, permanently lubricated ball bearings.

B. Motor: Open dripproof, single-speed motor.

C. Drive: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.4 service factor.
D. Mounting: Fan wheel, motor, and drives shall be mounted in fan casing with restrained, isolators.

2.5 REFRIGERATION SYSTEM
A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."
B. Compressors: Reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater.
C. Minimum Efficiency: As defined by ASHRAE/IESNA 90.1-2004, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."
D. Refrigerant: R-410A.
E. Refrigeration System Specialties:
1. Expansion valve with replaceable thermostatic element.
2. Refrigerant dryer.
3. High-pressure switch.
4. Low-pressure switch.
5. Thermostat for coil freeze-up protection during low ambient temperature operation or loss of air.
6. Brass service valves installed in discharge and liquid lines.
7. Operating charge of refrigerant.
F. Capacity Control: Hot-gas bypass refrigerant control for capacity control with continuous dehumidification on a single compressor.
G. Refrigerant Coils: Evaporator, condenser, and reheat condenser coils shall be designed, tested, fabricated, and rated according to ARI 410 and ASHRAE 33. Coils shall be leak tested under water with air at 315 psig.
1. Capacity Reduction: Circuit coils for row control.
2. Tubes: Copper.
3. Fins: Aluminum with minimum fin spacing of 0.071 inch.
4. Fin and Tube Joint: Mechanical bond.
5. Suction and Distributor: Seamless copper tube with brazed joints.
6. Coating: Phenolic epoxy corrosion-protection coating on both coils.
7. Source Quality Control: Test to 450 psig, and to 300 psig underwater.
H. Condenser Fan: Propeller type, directly driven by motor.
I. Safety Controls:
1. Compressor motor and outside-coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor and outside-coil fan motors.

2.6 DIRECT-FIRED GAS FURNACE
A. Description: Factory assembled, piped, and wired; complying with NFPA 54, "National Fuel Gas Code"; ANSI Z83.4, "Non-Recirculating Direct Gas-Fired Industrial Air Heaters"; and ANSI Z83.18, "Direct Gas-Fired Industrial Air Heaters," for direct-fired gas furnace.
B. Burners: Cast-iron burner with stainless-steel mixing plates.
1. Rated for a maximum turndown ratio of 30:1.
2. Fuel: Natural gas.
C. Safety Controls:

1. Gas manifold safety switches and controls shall comply with ANSI standards and FMG.
2. Pilot: Intermittent spark igniter.
3. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
4. External gas-pressure regulator shall regulate pressure to not more than 0.5 psig.
5. Airflow Proving Switch: Dual pressure switch senses correct airflow before energizing pilot and requires airflow to be maintained within minimum and maximum pressure settings across burner.
6. Manual-Reset, High-Limit Switch: Stops burner and closes main gas valve if high-limit temperature is exceeded.
7. Gas Train: Redundant, main gas valves, electric pilot valve, main and pilot gas-pressure regulators, main and pilot manual shutoff valves, main and pilot pressure taps, and high-low gas-pressure switches.

2.7 OUTDOOR-AIR INTAKE AND DAMPERS

A. Dampers: Leakage rate, according to AMCA 500, shall not exceed 2 percent of air quantity at face velocity of 2000 fpm through damper and pressure differential of 4-inch wg.
B. Damper Operators: Electric.
C. Mixing Boxes: Parallel-blade, galvanized-steel dampers mechanically fastened to steel operating rod inside cabinet. Connect operating rods with common interconnecting linkages so dampers operate simultaneously.
D. Outdoor-Air Intake Hoods: Galvanized steel, with bird screen complying with ASHRAE 62.1-2004 and finish to match cabinet.

2.8 FILTERS

A. Comply with NFPA 90A.
B. Cleanable Filters: 2-inch-thick, cleanable metal mesh.
C. Disposable Panel Filters: 2-inch-thick, factory-fabricated, flat-panel-type, disposable air filters with holding frames.
   1. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
   2. Frame: Galvanized steel.

2.9 CONTROLS

A. Control equipment and sequence of operation are specified in Division 23 Section "Instrumentation and Control for HVAC."
B. Factory-wire connection for controls' power supply.
C. Control devices, including sensors, transmitters, relays, switches, thermostats, humidistats, detectors, operators, actuators, and valves, shall be manufacturer's standard items to accomplish indicated control functions.
D. Unit Controls: Solid-state control board and components with field-adjustable control parameters.
E. Supply-Fan Control: Units shall be electrically interlocked with corresponding exhaust fans, to operate continuously when exhaust fans are running. Time clock shall switch operation from occupied to unoccupied. Night setback thermostat shall cycle fan during unoccupied periods to maintain space temperature.
   1. Timer: Seven-day electronic clock.

2. Electrically interlock kitchen hood fire-extinguishing system to de-energize replacement-air unit when fire-extinguishing system discharges.

F. Unit-Mounted Status Panel:
1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicates position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:
   a. Filter dirty.
   b. Fan operating.
   c. Cooling operating.
   d. Heating operating.

G. Refrigeration System Controls:
1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Wall-mounting, relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 60 percent.

H. Heating Controls:
1. Factory-mounted sensor in supply-fan outlet with sensor adjustment located in control panel modulates gas furnace burner to maintain space temperature.
2. Wall-mounting, space-temperature sensor with temperature adjustment adjustment on remote-control panel that modulates gas furnace burner to maintain space temperature.
3. Remote Setback Thermostat: Adjustable room thermostat selected by timer, set at 50 deg F; cycles supply fan and gas furnace burner to maintain space temperature.
4. Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual furnace units.

I. Damper Controls:
1. Wall-mounting pressure sensor modulates outdoor- and return-air dampers to maintain a positive pressure in space served by rooftop replacement-air unit at minimum 0.05-inch wg.
2. When exhaust fans stop, set outdoor- and return-air damper to 75 percent outdoor air. When exhaust fans start, close return-air damper and fully open outdoor-air damper.

J. DDC Temperature Control: Stand-alone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with temperature-control system specified in Division 23 Section "Instrumentation and Control for HVAC." Links shall include the following:
1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
   a. Room temperature.
   b. Discharge air temperature.
   c. Refrigeration system operating.
   d. Furnace operating.

2.10 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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 installation of rooftop replacement-air units.
B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
C. Examine roof curbs and equipment supports for suitable conditions where rooftop replacement-air units will be installed.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Roof curb: Turn over to the general contractor who shall install.
B. Install wall- and duct-mounting sensors, thermostats, and humidistats furnished by manufacturers for field installation. Install control wiring and make final connections to control devices and unit control panel.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to machine to allow service and maintenance.
    1. Gas Burner Connections: Comply with requirements in Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to rooftop replacement-air units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.
E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
B. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    1. Inspect for visible damage to furnace combustion chamber.
    2. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
    3. Inspect casing insulation for integrity, moisture content, and adhesion.
    4. Verify that clearances have been provided for servicing.
    5. Verify that controls are connected and operable.
    6. Verify that filters are installed.
    7. Clean outside coil and inspect for construction debris.

8. Clean furnace flue and inspect for construction debris.
9. Inspect operation of power vents.
10. Purge gas line.
11. Inspect and adjust vibration isolators.
12. Verify bearing lubrication.
13. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
14. Adjust fan belts to proper alignment and tension.
15. Start unit.
16. Start refrigeration system when outdoor-air temperature is within normal operating limits.
17. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
18. Operate unit for run-in period.
19. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    a. Measure gas pressure at manifold.
    b. Measure combustion-air temperature at inlet to combustion chamber.
    c. Measure flue-gas temperature at furnace discharge.
    d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
20. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.
    d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
24. Verify operational sequence of controls.
25. Measure and record the following airflows. Plot fan volumes on fan curve.
    a. Supply-air volume.
    b. Return-air volume.
    c. Outdoor-air intake volume.
26. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through outside coil or from outside coil to outdoor-air intake.
27. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. High-limit heat exchanger.
    b. Alarms.

C. After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.
D. Remove and replace components that do not pass tests and inspections and retest as specified above.
E. Prepare written report of the results of startup services.

F. 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 ADJUSTING

A. Adjust initial temperature and humidity set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop replacement-air units. Refer to Division 01 Section "Demonstration and Training."

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 237433

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.

1.2 SUMMARY

A. Section includes split-system air conditioning and heat pump units consisting of separate evaporator fan and compressor-condenser components.

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 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.

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 concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section, "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

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.

C. Wind-Restraint Performance:

1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 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. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Daikin.
3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
4. SANYO North America Corporation; SANYO Fisher Company.
5. Fujitsu.

2.3 INDOOR UNITS 5 TONS OR LESS

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.

3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
5. 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. Wiring Terminations: Connect motor to chassis wiring with plug connection.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
7. Filters: Permanent, cleanable.
8. Condensate Drain Pans:
   a. Fabricated with minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
   b. Single-wall, stainless-steel sheet.
   c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

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-410A.
      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. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 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.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

3.6 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 238126

SECTION 238219 - FAN COIL 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. Ducted fan coil units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:
   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which fan coil units 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.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil 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. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Coil Unit Filters: Furnish one complete set of spare filters for each filter installed.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. ENVIRO-TEC; brand of Johnson Controls International plc, Building Solutions North America.
   2. IEC (International Environmental Corporation); LSB Industries.
B. Fan Coil Unit Configurations: Row split.
   1. Number of Coils: One with two-pipe system.
C. Coil Section Insulation:
   1. 1/2-inch- thick, coated glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
   2. Insulate coil section.
   3. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
   4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
D. Drain Pans: Main and Auxiliary Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.
F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
   1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.

2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
4. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

G. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

H. MERV Rating: 8 when tested according to ASHRAE 52.2.
1. Non-woven synthetic throwaway..

I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
1. Motors: Comply with requirements in Section 230511 "Common Work Results for HVAC."

K. Control devices and operational sequence are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls".

L. Electrical Connection: Factory wire motors and controls for a single electrical connection.

M. Capacities and Characteristics:
1. Refer to equipment schedule on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

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

3.2 INSTALLATION OF FAN COIL UNITS

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
1. Install piping adjacent to machine to allow service and maintenance.

2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. 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.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

3.6 DEMONSTRATION

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

3.8 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.

END OF SECTION 238219

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 integral controls.
   6. 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.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For cabinet unit heaters 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.

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.

PART 2 - PRODUCTS

2.1 CABINET UNIT 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. Markel Products; a division of TPI Corporation.
5. Marley Electric Heating; a division of Marley Engineered Products.
6. QMark Electric Heating; a division of Marley Engineered Products.

B. Description: A factory-assembled and -tested unit complying with ARI 440.

1. Comply with UL 2021.

C. Coil Section Insulation: Comply with NFPA 90A or NFPA 90B. Unicellular polyethylene thermal plastic, preformed sheet insulation complying with ASTM C 534, Type II, except for density.

1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.24 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 C 411.
4. Adhesive: As recommended by insulation manufacturer and complying 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 standard paint, in color selected by Architect.

1. Vertical Unit, Exposed Front Panels: Minimum 0.035-inch thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Recessing Flanges: Steel, finished to match cabinet.
3. Control Access Door: Key operated.
4. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
5. 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. Permanent washable aluminum.

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. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

I. Basic Unit Controls:
1. Control voltage transformer.
2. Unit-mounted thermostat with the following features.
   a. Heat-off switch.
   b. Fan on-auto switch.
   c. Manual fan speed switch.
   d. Adjustable deadband.
   e. Concealed set point.
   f. Concealed indication.
   g. Deg F indication.

J. Electrical Connection: Factory wire motors and controls for a single field connection.

K. Capacities and Characteristics:
1. Refer to equipment 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 forelectrical 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. 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. Perform tests and inspection with the assistance of a factory-authorized service representative.
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 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.
C. 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. Engage a factory-authorized service representative to 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 238416.13 - OUTDOOR, MECHANICAL DEHUMIDIFICATION 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 packaged, factory-assembled and -tested, refrigerant-type, outdoor, mechanical dehumidification units designed for outdoor installation.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of outdoor, mechanical dehumidification unit.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each outdoor, mechanical dehumidification unit.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly of outdoor, mechanical dehumidification units.
   4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bass, rails, and frames for equipment mounting.
   5. Include diagrams for power, signal, and control wiring.

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.

D. Delegated Design Submittal: For 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.

E. 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 INFORMATIONAL SUBMITTALS
- A. Product Test Reports: For each outdoor, mechanical dehumidification unit, for tests performed by a qualified testing agency.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS
- A. Operation and Maintenance Data: For dehumidification units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Filters: One set(s) of each type of filter specified.
  2. Fan Belts: One set(s) for each belt-drive fan.

1.7 QUALITY ASSURANCE
- A. Testing Agency Qualifications: An NRTL.

1.8 COORDINATION
- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.9 WARRANTY
- A. Special Warranty: Manufacturer agrees to repair or replace components of outdoor, mechanical dehumidification units that fail in materials or workmanship within specified warranty period.
  1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
  2. Warranty Period for Refrigerant Coils: Manufacturer's standard, but not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OUTDOOR, MECHANICAL DEHUMIDIFICATION UNIT MANUFACTURERS
- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  1. Desert Aire.
  2. Approved equal.

2.2 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. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."
- D. ASHRAE 15 Compliance: "Safety Standard for Refrigeration Systems."
- E. 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."

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and wind restraints.
G. Wind-Restraint Performance:
   1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.
H. Capacities and Characteristics:
   1. Refer to equipment schedules on drawings.

2.3 CASINGS
A. Casing: Double-wall construction with exterior baked-enamel steel or aluminum, stainless-steel fasteners, knockouts for electrical and piping connections, condensate drain connection, and lifting lugs.
   1. Access: Hinged access doors with neoprene compression gaskets and cam latches.
   2. Insulation: Minimum 2-inch-thick, glass-fiber-insulation fill or closed cell foam, with thermal breaks.
   3. Fully weatherproof with cross-broken roof for drainage, rain hood or louver for outside air, and relief/exhaust air openings.
   4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
B. Drain Pan and Connection: Stainless steel; insulated.

2.4 FANS
A. Supply Fans:
   1. Blades: Forward curved or Backward inclined.
   2. Type: Housed or Unhoused plenum type, centrifugal.
   3. Blade and Housing Material: Galvanized steel with baked-enamel or powder-coated finish.
   4. Drive: Direct-driven with keyed motor shaft or Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit.
B. Exhaust Fans:
   1. Blades: Forward curved or Backward inclined.
   2. Type: Housed or Unhoused plenum type, centrifugal.
   3. Blade and Housing Material: Galvanized steel with baked-enamel or powder-coated finish.
   4. Drive: Direct-driven with keyed motor shaft or Belt-driven with adjustable sheaves and self-aligning, grease-lubricated ball bearings, with extended grease fittings easily accessible inside the casing of the dehumidification unit.
C. Fan Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Enclosure Type: Totally enclosed, fan cooled.
D. Variable-Frequency Motor Controller: Comply with Section 262923 "Variable-Frequency Motor Controllers."
E. Variable-Frequency Motor Controller:
   1. Manufactured Units: Pulse-width modulated; constant torque and variable torque for inverter-duty motors.
   2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

3. Unit Operating Requirements:
   a. Internal Adjustability:
      1) Minimum Speed: 5 to 25 percent of maximum rpm.
      2) Maximum Speed: 80 to 100 percent of maximum rpm.
      3) Acceleration: 0.1 to 999.9 seconds.
      4) Deceleration: 0.1 to 999.9 seconds.
      5) Current Limit: 30 to minimum of 150 percent of maximum rating.
   b. Self-Protection and Reliability Features:
      1) Surge suppression.
      2) Loss of input signal protection.
      3) Under- and overvoltage trips.
      4) Variable-frequency controller and motor-overload/overtemperature protection.
      5) Critical frequency rejection.
      6) Loss-of-phase protection.
      7) Reverse-phase protection.
      8) Motor-overtemperature fault.
   c. Bidirectional autospeed search.
   d. Torque boost.
   e. Motor temperature compensation at slow speeds.
      1) Panel-mounted operator station.
      2) Historical logging information and displays.
      3) Digital indicating devices.
   f. Control Signal Interfaces: Electric.
   g. Proportional-integral-derivative control interface.
   h. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.
4. Line Conditioning:
   a. Input line conditioning.
   b. Output filtering.
   c. EMI/RFI filtering.
5. Bypass Systems:
   a. Bypass Mode: Field-selectable automatic or manual.
   b. Bypass Controller: Three-contactor style, with bypass and input and output isolating contactors and isolating switch.
   c. Bypass Contactor Configuration: Full-voltage (across the line) type.

2.5 FILTERS

A. Pleated:
   1. Thickness: 2 inches.
   2. MERV Rating: MERV 13, according to ASHRAE 52.2.

2.6 REFRIGERATION SYSTEM

A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1.
B. Refrigerant Coils with Multiple Refrigerant Circuits:
   1. Tubes: Copper.
   2. Fins:
      a. Material: Aluminum.
   3. Fin and Tube Joints: Mechanical bond.
   4. Headers: Seamless-copper headers with brazed connections.

5. Frames: Galvanized-steel frame.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
8. Source Quality Control: Factory test to minimum 450-psig internal pressure and to minimum 300-psig internal pressure while underwater.

C. Compressors: Hermetic, scroll compressors with integral vibration isolators and crankcase heaters that de-energize during compressor operation; with thermal-expansion valves, filter-dryers, sight glasses, compressor service valves, and liquid- and suction-line service valves.
1. Minimum Number of Refrigerant Circuits: Two for compressor capacities of more than 7-1/2 tons.
2. Refrigerant: R-410A.
3. Capacity Control:
   a. The unit shall include hot gas bypass for each system compressor set. The hot gas bypass shall be used for the prevention of coil freeze up and not for compressor unloading.
   b. Cycle compressor.
4. Low-Pressure Cutout: Manual reset after three automatic-reset failures.
5. High-Pressure Cutout: Manual reset.
6. Compressor Motor Overload Protection: Manual reset.
7. Antirecycling Timing Device: Prevent compressor restart for five minutes after shutdown.
8. Defrost Cycle: Adjustable timer shuts off supply fan. Compressor cycles until suction-line temperature confirms thawed evaporator coil.
9. The unit shall include a high-side refrigerant receiver.

2.7 EVAPORATOR DEHUMIDIFIER COILS

A. Fins: Fins shall be die-formed, raised lanced aluminum, and damage resistant. Extruded fin collars provide maximum heat transfer. Fin spacing shall be 10 fins per inch (FPI). On units without the enthalpy wheel option the coil shall be a maximum of 40” in height. On units with the enthalpy wheel option the coil shall be a maximum of 47” in height.

B. Tubes: Coil shall be fabricated from seamless drawn copper. The inner tubing shall be rifled to produce turbulent refrigeration flow to enhance the heat transfer process. The tubes shall be hydraulically expanded into the fins to form a permanent metal-to-metal bond for maximum heat transfer and stability. On units without the enthalpy wheel option the coil shall be a minimum of six (6) rows deep. On units with the enthalpy wheel option the coil shall be a minimum of three (3) rows deep.

C. Coils shall be leak tested with 420 psig nitrogen and U.L listed.

2.8 WATER SOURCE HEAT PUMP

A. The water cooled dehumidifier shall be equipped with a liquid chiller that allows the refrigerant to extract heat from a water loop during heat pump operation.

B. The liquid chiller shall be piped in series with a water condenser first with respect to incoming water flow from the water loop. Unwanted heat shall be rejected back to the water loop for maximum energy efficiency to control leaving air temperature to set point.

C. The system shall be capable of simultaneous heat of rejection to both the hot gas reheat coil and the water condenser and control the SAT within +/- 0.2°F.

D. The liquid chiller and the water condenser shall be brazed plate heat exchanger. The heat exchanger shall consist of stainless steel plates copper brazed together to resist a maximum working temperature of 350°F. The heat exchanger shall be factory helium leak tested at 500-psi for quality assurance and have a maximum working pressure of 450-psi. The brazed plate heat exchanger shall be UL listed.
E. The head pressure shall be controlled by the system's internal flooding valve.
F. Units shall have the liquid chiller wrapped in insulation and heat traced. The heat tracing shall be wired back to the control panel for an independent 120V power connection.

2.9 INTEGRAL, AIR-COOLED CONDENSER (REHEAT COIL)
A. Description: Mounted on same framing skid as outdoor, mechanical dehumidification unit.
B. Casing: Steel, baked-enamel finish, with access doors or 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.
C. Refrigerant Coil:
1. Copper tube with mechanically bonded aluminum fins; with liquid subcooler.
2. Coating: None.
3. The reheat coil shall be positioned with a minimum of 5” clearance from the evaporator coil to prevent water re-evaporation. Direct connection of the reheat coil to the DX coil is not allowed.
D. Fan: Aluminum-propeller type, directly connected to permanently lubricated motor with integral thermal-overload protection.
E. Adjustable, Low Ambient Head-Pressure Control: Designed to operate at temperatures as low as 0 deg F by cycling condenser fans and controlling speed of last fan of each circuit.
F. Mounting Base: Same material as unit base.

2.10 DAMPERS
A. Outdoor-, Return-, and Exhaust-Air Dampers:
1. Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers.
2. Compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement.
3. Zinc-plated-steel operating rods rotating in stainless-steel sleeve bearings mounted in a single galvanized-steel frame.
4. Operating rods connected with a common linkage.
5. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.
B. Damper Operator: 115 or 24 V ac, close coupled, with gear train sealed in oil and with spring return.

2.11 EXHAUST AIR ENERGY RECOVERY ROTARY WHEEL SYSTEM
A. Wheel Design: The rotor matrix shall be manufactured of a corrosion resistant aluminum alloy that is composed of alternating corrugated and flat, continuously wound layers of uniform widths to guarantee laminar air flow, and low static pressure loss. The matrix will have a minimum depth of 7.5 inches.
B. Desiccant Type: All corrugated surfaces must be coated with a thin non-migrating synthetic zeolite absorbent layer; with a pore size no greater than a 4 Angstrom; prior to being formed into the media structure to insure that all surfaces are coated and that

adequate latent capacity is provided. The wheel's effectiveness is documented through a certification program conducted in accordance with ASHRAE 84 and ARI 1060 standards. The certification is conducted by a qualified independent organization that is recognized by AHRI.

C. Unit Housing: The self supported housing shall be made of galvanized steel to prevent corrosion. For rotor housings 2000 mm (79 inches) and less, the rotor wheel is supported by two internal, maintenance-free, antifriction, permanently sealed bearings that are located and protected within the surrounding wheel hub. For rotor housings larger than 2000 mm (79 inches), the rotor wheel shall be supported by two maintenance-free sealed pillow block bearings that are located within the housing and protected from the air stream.

D. Rotor Seals: The rotor shall be sealed with a wear resistant adjustable perimeter seal fitting completely around the rotor wheel. A purge shall be provided to minimize cross-contamination.

E. Drive System: The rotor wheel shall be driven by a self-adjusting belt system, which includes a A/C motor, nylon reinforced belt with linkage, and a spring-tensioned motor plate. The A/C motor shall be capable of performing under constant and variable speed applications.

F. Certification: The wheel's effectiveness shall be documented through a certification program conducted in accordance with ASHRAE 84 standards and ARI 1060. The certification shall be conducted by a qualified independent organization that is recognized by AHRI.

G. Frost Protection: The manufacturer shall provide a Variable Frequency Drive (VFD). The VFD shall drive the wheel at maximum speed until the exhaust air's relative humidity reaches 95% to eliminate wheel frosting.

H. The VFD shall vary the wheel speed to maintain the RH maximum to optimize energy recovery.

2.12 CONTROLS

A. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC" for control equipment and in Section 230993 "Sequence of Operations for HVAC Controls."

B. Control Panel: Integral service compartment containing fan-motor thermal and overload cutouts, compressor thermal and overload cutouts, 115-V control transformer if required, magnetic contactors for fan and compressor motors, and a nonfused factory-mounted and -wired disconnect switch for single external electrical power connection.

C. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms.

D. Operating Control: Space humidistat cycles the compressor. Humidistat shall incorporate fan on-off-auto switch.

E. Operating Control: Factory-installed microprocessor controller, capable of being remotely mounted.

1. Display the following on the face of controller:
    a. System on.
    b. System dehumidifying mode.
    c. System air-conditioning mode.
    d. System outdoor-air (economizer) mode.
    e. Auxiliary space heat is operating.
    f. Unit requires service.
    g. Return-air (space) temperature.

h. Return-air (space) humidity.
i. Outdoor-air temperature.

2. Indicate the following sensor failures on panel:
   a. Airflow: Dirty air filter, blocked airflow, and fan failure.
   b. Refrigerant high and low pressure.
   c. High water temperature.
   d. High and low evaporator temperature.
   e. Low water flow.
   f. Communication fault.
   g. System off.
   h. Antishort cycle delay.
   i. Power failure.
3. Provide access to the following set points on panel:
   a. Space temperature.
   b. Space relative humidity.
   c. Outdoor ventilation/air-conditioning changeover temperature.
   d. Airflow alarm.
4. Provide the following displays on panel:
   a. Space temperature.
   b. Space relative humidity.
   c. Outdoor-air temperature.
   d. Supply-air temperature.
   e. Return-air temperature.
   f. Airflow rating.
   g. Air-off evaporator temperature.
   h. Return-air relative humidity.
   i. Service codes.
5. Provide the following controls on panel:
   a. System on-off, fan continues to run.
   b. Fan on-off.
   c. Service code access.
   d. System dehumidifying mode.
   e. System air-conditioning mode.
   f. System outdoor-air (economizer) mode.
   g. Auxiliary space heat is operating.
   h. Outdoor-air-temperature, conditioned-space-temperature, and control set-point-temperature digital display.
   i. Outdoor enthalpy digital display.
   j. Filter pressure drop digital display.
   k. Status: Airflow, fans, system, unit operation, and operating mode.
   l. Alarm digital display.

F. Operating Control: Factory-installed microprocessor controller.
1. Factory-installed operator panel with backlit display, capable of being remotely mounted, allows menu-driven display for navigation and control of unit.
2. Integral clock.
3. Personal computer interface.
4. Integral LAN for direct connection to BACnet.
5. Factory programmed.
6. Unit-Mounted Sensors:
   a. Airflow switch.

b. Compressor-discharge temperature.
c. Evaporator-air temperature.
d. Relative humidity.
e. Return-air temperature.
f. Supply-air temperature.

7. Integral diagnostics.
8. Nonvolatile memory.
9. IP or SI display.
10. Provide the following status and alarm functions:
    a. System: On-off.
    b. Power failure.
    c. Fan: Off, overload.
    d. Compressor: On, turned off, overload, high pressure, low pressure, overheat, oil failure, and pumpdown.
    e. Evaporator damper closed.
    f. Pool: Low water flow, heating on.
    g. Dehumidification: Call for, on.
    h. Air Conditioning: Call for, on.
    i. System outdoor-air (economizer) mode.
    j. Auxiliary space heat on.
    k. Alarms: Firestat, freezestat, and filters.
11. Provide the following controls via operator panel:
    a. Compressor auto-off.
    b. Fan auto-off.
    c. Set-Point Adjustments: Relative humidity, temperatures, deadbands, and differentials.
    d. Sensor calibration.

2.13 ACCESSORIES

A. Electrical Convenience Outlet: 125 V ac, duplex, straight-blade receptacles, separately fused and located inside control panel.

2.14 ROOF CURBS

A. Roof Curbs:
    1. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
    2. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
        a. Materials: ASTM C1071, Type I or II.
        b. Thickness: 1-1/2 inches.
        c. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
        d. Liner Adhesive: Comply with ASTM C916, Type I.
        e. 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.
        f. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service-air velocity.
B. Curb Height: 24 inches.

2.15 MATERIALS
- A. Steel:
  1. ASTM A36/A36M for carbon structural steel.
  2. ASTM A568/A568M for sheet steel.
- B. Stainless Steel:
  1. Manufacturer's standard grade for casing.
  2. Manufacturer's standard type, ASTM A240/240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.

2.16 SOURCE QUALITY CONTROL
- A. Verification of Performance: Factory test and rate dehumidification units according to AHRI 910.
- B. Sound-Power-Level Ratings: Factory test and rate dehumidification units according to AHRI 575.

PART 3 - EXECUTION

3.1 EXAMINATION
- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine walls, floors, and roofs for suitable conditions where dehumidification units will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
- A. Equipment Mounting:
  1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 PIPING CONNECTIONS
- A. Where piping is installed adjacent to dehumidification units, allow space for service and maintenance of dehumidification units.
- B. Connect piping to dehumidification units mounted on vibration isolators with flexible connectors.
- C. Connect condensate drain pans using minimum NPS 1-1/4 copper tubing. Extend to nearest roof drain. Construct deep trap at connection to drain pan, and install cleanout at changes in direction.
- D. Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  1. Install ducts to termination in roof-mounted frames. Where indicated, terminate return-air duct through roof structure, and insulate the space between roof and bottom of dehumidification unit.

3.4 ELECTRICAL CONNECTIONS
- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring between control devices.
C. Connect smoke detector to fire alarm system.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
   1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
   2. Charge refrigerant coils with refrigerant and test for leaks. Repair leaks and retest until no leaks exist.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
B. Dehumidification unit will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.7 CLEANING

A. Clean dehumidification units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering-air face.
B. After completing system installation, testing, and startup service of dehumidification units, clean filter housings and install new filters.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Adjust initial temperature and humidity set points.

3.9 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. Perform the following final checks before startup:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Perform cleaning and adjusting specified in this Section.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
   5. Check lubrication of bearings, pulleys, belts, and other moving parts.
   6. Set outside- and return-air mixing dampers to minimum outside-air setting.
   7. Install clean filters.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for dehumidification units include the following:
   1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace malfunctioning motors, bearings, and fan wheels.
   2. Measure and record motor's electrical values for voltage and amperage.
   3. Manually operate dampers from fully closed to fully open position and record fan performance.

D. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing of dehumidification unit.

E. Startup Report: Report findings during startup. Identify startup steps, corrective measures taken, and final results.

F. 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.

3.10 DEMONSTRATION

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

3.11 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 238416.13

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. 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.

2.3 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.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. 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.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. 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.

2.4 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 2 inches above finished floor level.
G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section, "Joint Sealants.".
J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section, "Penetration Firestopping."
K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and 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 equipment on the circuit or to a central location of the associated circuit and acts as a distribution point to the devices or equipment indicated to be power 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.

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. 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. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS
A. 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. Feeders in Cable Tray: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
F. Branch Circuits Concealed in Ceilings, Walls, and Partitions:
   1. Home run: Type THHN-THWN, single conductors in raceway.
   2. Between devices/equipment, wire to same source branch circuit: Type THHN-THWN. Metal-clad cable, Type MC.
G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

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. 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 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.

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.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, 3/4 inch in diameter by 10 feet.

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. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. 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.

E. 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.

F. 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 Requirements:
   1. Section 260548 “Vibration and Seismic Controls for Electrical Systems” for vibration isolation devices and seismic restraints.

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:
   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.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. 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. 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) 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. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
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 [or other] support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To New Concrete: Bolt to concrete inserts.
   2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   3. To Existing Concrete: Expansion anchor fasteners.
   4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
   5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   6. To Light Steel: Sheet metal screws.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. 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.

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.
J. RMC: Rigid metallic conduit (galvanized)

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. 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. 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] [IMC].
   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:
   1. AFC Cable Systems, Inc.
   2. CANTEX Inc.
   3. Lamson & Sessions; Carlon Electrical Products.
   4. RACO; a Hubbell Company.
   5. Thomas & Betts Corporation.
B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.
C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 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. Hubbell Wiring Device-Kellems: a Hubbell Company.

2.4 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. Hoffman.
   3. O-Z/Gedney; a unit of General Signal.
   4. RACO; a Hubbell Company.
   5. Thomas & Betts Corporation.
B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

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. Exposed and Subject to Severe Physical Damage: RMC. Includes raceways in the following locations:
      a. Loading dock.
      b. Mechanical rooms.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: Rigid steel conduit.
   7. 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. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. 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.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. 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.

K. Flexible Conduit Connections: Use maximum of 48 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

L. 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."
   3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
   4. 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.
   5. 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.
   6. Warning Tape: Bury warning tape approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align tape 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 260548 - VIBRATION AND SEISMIC CONTROLS 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. Elastomeric isolation pads.
   2. Restraints - rigid type.
   3. Restraints - cable type.
   4. Restraint accessories.
   5. Post-Installed concrete anchors.
   6. Concrete inserts.

B. Related Requirements:
   1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated load capacity for each seismic-restraint device.
   2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
   3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by UL product listing, FM Approvals and OSHPD.
   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. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.
   1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:
      a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
      b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
      c. Seismic Design Calculations: Submit input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.

2. Seismic-Restraint Detail Drawings: Signed and sealed by qualified structural professional engineer.
   a. Design Analysis: To support selection and arrangement of seismic 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.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified structural professional engineer to design seismic control system as defined in Section 014000 “Quality Requirements,” to design seismic control system.

B. Seismic-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: UL product listing and FM Approvals.

C. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:
   1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
   1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
   2. Size: Factory or field cut to match requirements of supported equipment.
   3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
   4. Surface Pattern: Smooth, ribbed, or waffle pattern.
   5. Load-bearing metal plates adhered to pads.

2.3 RESTRAINTS - RIGID TYPE

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

2.4 RESTRAINTS - CABLE TYPE

A. Seismic-Restraint Cables: ASTM A1023/A1023M 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.

B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. 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.

2.5 RESTRAINT ACCESSORIES

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

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. 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.

D. 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.

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

2.6 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. 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. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

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.

2.7 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

B. Comply with MSS SP-58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS
A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES
A. Provide seismic restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
D. 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 seismic-restraint devices using methods approved an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
F. Install cables so they do not bend across edges of adjacent equipment or building structure.
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 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 must 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction.
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 post-connection testing has been approved), and with at least seven days' advance notice.
   3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   4. Test 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.
C. Nonconforming Work:
   1. Seismic controls will be considered defective if they do not pass tests and inspections.
   2. Remove and replace malfunctioning units and retest as specified above.
D. Prepare test and inspection reports.

END OF SECTION 260548

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 for conductors.
   3. Underground-line warning tape.
   4. Warning labels and signs.
   5. Equipment identification labels.
   6. 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, circuit number, circuit source
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 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.

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. Verify identity of each item before installing identification products.
B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
C. Apply identification devices to surfaces that require finish after completing finish work.
D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
F. 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.

G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, 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. Lighting Inverter Emergency Power.
   2. 120/208 volt power.
   3. 277/480 volt power.
   4. Fire alarm.

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 feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480/277-V Circuits:
         1) Phase A: Brown.
         2) Phase B: Orange.
         3) Phase C: Yellow.
      d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. 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.

E. 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. Emergency system boxes and enclosures.
    d. Enclosed switches.
    e. Variable-speed controllers.
    f. Push-button stations.
    g. Contactors.
    h. Battery-inverter units.

END OF SECTION 260553

SECTION 260800 - COMMISSIONING OF 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 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 Enlarged City School District of Middletown will manage the commissioning process.

1.3 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”.

1.4 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.

1.5 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.

1.6 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.

1.7 CxA'S RESPONSIBILITIES

A. Include CxA responsibilities in this article that have an impact on Contractor's activities and responsibilities.
B. 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.
C. Direct commissioning testing.
D. Provide test data, inspection reports, and certificates in Systems Manual.
E. The CxA will be appointed by and work directly for The Enlarged City School District of Middletown.

1.8 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.

1.9 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. Daylight-Harvesting Dimming Controls, Digital
   3. Conductors and Cables
   4. Switchbox-Mounted Motion Sensors
   5. 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. Steinel Lighting Controls
2. Hubbell Lighting
3. Leviton Mfg. Company Inc.
4. Sensor Switch, 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.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS, DIGITAL

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. Steinel Lighting Controls
   2. Hubbell Lighting
   3. Leviton Mfg. Company Inc.
   4. Sensor Switch Inc.

B. 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.

C. 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.

D. 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.

2.3 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."

2.4 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. Steinel Lighting Controls
   2. Hubbell Lighting
   3. Leviton Mfg. Company Inc.
   4. Sensor Switch, 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.

2.5 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. Eaton Electrical Inc.; Cutler-Hammer Products
   2. General Electric Company
   3. Hammond Co.; Matra Electric, Inc.
   4. Myers Power Products, Inc.
   5. Siemens Energy & Automation, Inc.
   6. 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 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Transient voltage suppression devices.
   3. Disconnecting and overcurrent protective devices.
   4. Identification.
   5. Mimic bus.

1.3 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Include evidence of NRTL listing for series rating of installed devices.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.
   9. Include diagram and details of proposed mimic bus.
   10. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Manufacturer Seismic Qualification Certification: Submit certification that switchboards accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Operation and Maintenance Data: For switchboards 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. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
B. 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.
C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
E. 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.
F. Comply with NEMA PB 2.
G. Comply with NFPA 70.
H. Comply with UL 891.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

1.6 PROJECT CONDITIONS

A. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.

B. Service Conditions: NEMA PB 2, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.

C. Comply with NFPA 70E

1.7 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 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.

1.9 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Siemens Energy & Automation, Inc.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.

B. Front- and Side-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Indoor Enclosures: Steel, NEMA 250, Type 1.

D. Barriers: Between adjacent switchboard sections.

E. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

H. Phase, Neutral, and Ground Buses:
1. Material: Tin-plated copper.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

I. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 TRANSIENT VOLTAGE SUPPRESSION 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. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, wired-in, solid-state, with sine-wave tracking suppression and filtering modules, UL 1449, fourth edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:
1. Fuses, rated at 250-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Redundant suppression circuits.
4. Redundant replaceable modules.
5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
6. LED indicator lights for power and protection status.
7. Audible alarm, with silencing switch, to indicate when protection has failed.
8. Form-C contacts rated at 1 A and 125-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
9. Transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: 250kA per phase.

D. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277V & 208Y/120V, three-phase, four-wire circuits shall be as follows:
1. Line to Neutral: 320V for 480Y/277 and 150V for 208Y/120V.
2. Line to Ground: 320V for 480Y/277 and 150V for 208Y/120V

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
   7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
   8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
      c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      d. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
      e. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
      f. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
      g. Instantaneous trip.
      h. Long- and short-time time adjustments.
      i. Ground-fault pickup level, time delay, and I^2t response.
   9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   10. Remote trip indication and control.

2.4 IDENTIFICATION

A. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.
B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to switchboards.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
E. Install filler plates in unused spaces of panel-mounted sections.
F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges.
G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with 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 switchboard 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 switchboard. 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 switchboard 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.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. 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 switchboard, 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, until switchboard is ready to be energized and placed into service.

3.7 DEMONSTRATION

A. Train owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 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. Lighting and appliance branch-circuit Panelboards.
   2. Distribution Panelboards.

B. Related Requirements”
   1. Section 260548 ‘Vibration and Seismic Controls for Electrical Systems’

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device. 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.

1.4 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.

1.5 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.

1.6 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.

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 Managerno fewer than 7 days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.7 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.

1.8 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.

1.9 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: 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.
      c. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.

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 sections.
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.
7. Directory Card: Inside panelboard door, mounted in transparent card holder.

C. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. 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.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 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: Circuit breaker.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.3 EXISTING PANELS

A. All new circuit breakers to be provided and installed in existing panels shall be from the same manufacturer as the panel.
B. Circuit breakers shall be listed for use in the intended panel and shall meet or exceed the A.I.C. rating of the panel.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   2. Siemens Energy & Automation, Inc.
   3. Square D; a brand of Schneider Electric.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. 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 top of trim 90 inches above finished floor unless otherwise indicated.
E. Mount panelboard cabinet plumb and rigid without distortion of 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. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
I. 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. 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. Snap switches.
   3. Floor Boxes.

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, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Color shall be as approved by architect.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
B. Duplex GFCI Convenience Receptacles, 125 V, 20 A. Color shall be as approved by architect.

2.4 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.
B. Switches, 120/277 V, 20 A. Color shall be as approved by architect.

2.5 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with baked enamel, color shall be as approved by architect.
3. Material for Unfinished Spaces: Galvanized steel.
B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover

2.6 FLOOR SERVICE FITTINGS (FLOOR BOX)

A. Type: Modular, flush-type dual-service units suitable for wiring method used.
B. Compartments: Barrier separates power from voice and data communication cabling.
C. Service Plate: Die-cast aluminum with finish selected by Architect. Cover shall be of same manufacturer as floor box.
D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.
E. Voice and Data Communication Outlet: Refer to schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
B. Coordination with Other Trades:
1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.
C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
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. Tighten unused terminal screws on the device.
6. 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. Nonfusible switches.
   2. Enclosures.
   3. Circuit breakers.

1.3 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPST: Single pole, single throw.
D. 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. 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, 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.
   2. Altitude: Not exceeding 6600 feet.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager and owner no fewer than 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 Construction Manager and Owner's written permission.
   4. Comply with NFPA 70E.

1.7 COORDINATION

A. Coordinate layout and installation of switches, 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 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of 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. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.2 CIRCUIT BREAKERS

A. Circuit breakers provided for use in existing panelboards shall be listed for use in the intended panelboard and shall meet or exceed the A.I.C. rating of the panelboard.

2.3 ENCLOSURES

A. Enclosed Switches: 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 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 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. 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, 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 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 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.
B. CE: Conformite Europeene (European Compliance).
C. CPT: Control power transformer.
D. EMI: Electromagnetic interference.
E. IGBT: Insulated-gate bipolar transistor.
F. LAN: Local area network.
G. LED: Light-emitting diode.
H. MCP: Motor-circuit protector.
I. NC: Normally closed.
J. NO: Normally open.
K. OCPD: Overcurrent protective device.
L. PCC: Point of common coupling.
M. PID: Control action, proportional plus integral plus derivative.
N. PWM: Pulse-width modulated.
O. RFI: Radio-frequency interference.
P. TDD: Total demand (harmonic current) distortion.
Q. THD(V): Total harmonic voltage demand.
R. VFC: Variable-frequency motor controller.

1.4 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
    1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
        a. Each installed unit's type and details.
        b. Factory-installed devices.
        c. Enclosure types and details.
        d. Nameplate legends.
        e. Short-circuit current (withstand) rating of enclosed unit.

f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

C. Product Certificates: For each VFC, from manufacturer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For VFCs 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 thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

F. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

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.

C. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.6 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and connect factory-installed space heaters to temporary electrical service.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 3300 feet (1005 m).

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions

and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   1. ABB.
   2. Danfoss Inc.; Danfoss Drives Div.
   3. Square D; a brand of Schneider Electric.
   4. Toshiba International Corporation.
   5. Yaskawa Electric America, Inc; Drives Division.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:
   1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
   2. Input AC Voltage Unbalance: Not exceeding 3 percent.
   3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
   4. Minimum Efficiency: 96 percent at 60 Hz, full load.
   5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
   6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.
   7. Vibration Withstand: Comply with IEC 60068-2-6.
   8. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
   9. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
   10. Speed Regulation: Plus or minus 5 percent.
   11. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
   12. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
   1. Signal: Electrical.

J. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with three selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Loss-of-phase protection.
   9. Reverse-phase protection.
   10. Short-circuit protection.
   11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NC alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION
A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.
B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:
      a. Coordinate number of programmable analog inputs/outputs with control contractor, refer to points list on mechanical drawings: 4- to 20-mA dc. Provide additional contacts as required.
      b. Coordinate number of multifunction programmable digital inputs/outputs with control contractor, refer to points list on mechanical drawings. Provide additional contacts as required.
   2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
      a. 4- to 20-mA dc.
   3. Output Signal Interface: A minimum of one programmable analog output signal(s) 4- to 20-mA dc, which can be configured for any of the following:
      a. Output frequency (Hz).
      b. Output current (load).
      c. DC-link voltage (V dc).
      d. Motor torque (percent).
      e. Motor speed (rpm).
      f. Set point frequency (Hz).
   4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      a. Motor running.
      b. Set point speed reached.
      c. Fault and warning indication (overtemperature or overcurrent).
      d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.

2.3 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
   1. NORMAL/BYPASS selector switch.
   2. HAND/OFF/AUTO selector switch.
   3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
   4. Contactor Coils: Pressure-encapsulated type.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
      b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
      a. CPT Spare Capacity: 100 VA.
   6. Overload Relays: NEMA ICS 2.
      a. Melting-Alloy Overload Relays:
         1) Inverse-time-current characteristic.
         2) Class 10 tripping characteristic.
         3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
      b. Bimetallic Overload Relays:
         1) Inverse-time-current characteristic.
         2) Class 10 tripping characteristic.
         3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
         4) Ambient compensated.
         5) Automatic resetting.
      c. Solid-State Overload Relays:
         1) Switch or dial selectable for motor-running overload protection.
         2) Sensors in each phase.
         3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
         4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
         5) Analog communication module.

d. NC isolated overload alarm contact.
e. External overload reset push button.

2.4 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1.

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
B. VFCs 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, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Install fuses in each fusible-switch VFC.
E. Install fuses in control circuits if not factory installed.
F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system.

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
   5. Test each motor for proper phase rotation.
   6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. 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.
B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.
D. Set the taps on reduced-voltage autotransformer controllers.
E. Set field-adjustable circuit-breaker trip ranges.
F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

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 pressure-maintenance pumps.
   3. 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 20.

B. IEEE Compliance: Fabricate and test enclosed controllers in accordance with IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

C. 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 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.

2.4 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.

2.5 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. See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Fire-pump controllers will be considered defective if they do not pass tests and inspections.

D. 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. Seismic Bracing: Comply with requirements specified in Section 260548 "Seismic Controls for Electrical Systems."
F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
G. 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 260523 "Control-Voltage Electrical Power Cables."
B. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Section 284621.11 "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 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.

END OF SECTION 262933

SECTION 263213 - ENGINE GENERATORS

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 packaged engine-generator sets for standby power supply with the following features:
   1. Diesel Engine
   2. Unit-mounted cooling system.
   3. Unit-mounted control and monitoring.
   4. Performance requirements for sensitive loads.
   5. Outdoor enclosure.

B. Related Requirements:
   1. Section 260548 ‘Vibration and Seismic Controls for Electrical Systems’

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 SUBMITTALS

A. Product Data: For packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
   1. Thermal damage curve for generator.
   2. Time-current characteristic curves for generator protective device.

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. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
   2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
   4. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that engine-generator set, batteries, battery racks, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Qualification Data: For installer and testing agency.
E. Source quality-control test reports.
1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

F. Field quality-control test reports.
G. Operation and Maintenance Data: For packaged engine generators 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. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
C. 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), 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.

D. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

E. 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.

F. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).

G. Comply with NFPA 70 (National Electrical Code).

H. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

I. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

J. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: 0 deg to 104 deg F.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 4000 ft

1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate work in this section with Section 260913 Power Monitoring and Control.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 24 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Cummins Power Generation
   2. Caterpillar; Engine Div.
   3. Generac Power Systems, Inc.
   4. Kohler Co.; Generator Division.

2.2 DIESEL ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

C. Capacities and Characteristics:
   1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 450.0kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz
   2. Alternator shall be capable of accepting maximum 1766.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

D. Generator-Set Performance:
   1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
   2. Transient Voltage Performance: Not more than 13 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three (3) second.
   3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
   4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
   5. Transient Frequency Performance: Less than 3 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three (3) seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: Comply with NFPA 110, Type 10, system requirements.

E. Diesel Engine
1. Fuel: ASTM D975 #2 Diesel Fuel
2. Rated Engine Speed 1800 rpm.
3. Lubrication System: The following items are mounted on engine or skid:
   a. Lube Oil Pump: shall be positive displacement, mechanical, full pressure pump.
   b. Filter and Strainer: provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
   c. 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.
4. Engine Fuel System: shall be installed in strict compliance to the engine manufacturer's instructions.
5. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
6. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
   a. Designed for operation on a single 208 VAC, Single phase, 60Hz power connection.
   b. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
   c. Provided with a 24VDC thermostat, installed at the engine thermostat housing
7. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
8. Cooling System: Closed loop, liquid cooled
   a. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
   b. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   c. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

d. 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.
e. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

9. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Silencer shall be inside the enclosure.
10. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
11. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
    a. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
    b. Cranking Cycle: As required by NFPA 110 for level 1 systems.
    c. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
        1) Battery Compartment: Factory fabricated of metal with acid-resistant finish.
    d. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
    e. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
        1) Operation: Equalizing-charging rate based on generator set manufacturer’s recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
        2) Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
        3) Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
        4) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
        5) Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate

charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.

6) Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

F. Fuel Oil Storage
1. Comply with NFPA 30.
2. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be listed and labeled. The fuel tank shall include the following features:
   a. Capacity: Fuel for 24 Hour(s) continuous operation at 100 percent rated power output.
   b. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
   c. Electrical stub up(s)
   d. Normal & emergency vents
   e. Lockable fuel fill
   f. Mechanical fuel level gauge
   g. High and low level switches to indicate fuel level
   h. Leak detector switch
   i. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
   j. Fill port with overfill prevention valve (OFPV)
   k. 5 gallon fill/spill dam or bucket
   l. Tank design shall meet the regional requirements for the Project location

2.3 CONTROL AND MONITORING

A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.

B. Control shall be coordinate with Fire Pump Controller.

C. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in Fire Pump Controller initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch (Fire Pump Controller) also shuts down generator set.

D. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of local (generator set-mounted) and/or remote emergency-stop switch (Fire Pump Controller) also shuts down generator set.

E. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and

monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.

F. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
   1. AC voltmeter (3-phase, line to line and line to neutral values).
   2. AC ammeter (3-phases).
   3. AC frequency meter.
   4. AC kW output (total and for each phase). Display shall indicate power flow direction.
   5. AC kVA output (total and for each phase). Display shall indicate power flow direction.
   6. AC Power factor (total and for each phase). Display shall indicate leading or lagging condition.
   7. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
   8. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
   9. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
   10. DC voltmeter (alternator battery charging).
   11. Engine-coolant temperature gage.
   12. Engine lubricating-oil pressure gage.
   13. Running-time meter.
   14. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values).
   15. Fuel tank derangement alarm.
   16. Fuel tank high-level shutdown of fuel supply alarm.
   17. Generator overload.
   18. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR, reverse kW, over load (kW) short circuit, over current, loss of voltage reference, and over excitation shut down protection. There shall be a ground fault alarm, overload warning, and overcurrent warning alarm.
   19. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
   20. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
   21. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.

22. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

G. Control Heater: Generator shall be provided with control heaters for anti-condensation protection.

H. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

I. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 26 Section "Power Monitoring and Control."

J. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.4 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:

1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
6. The protective system provided shall not include an instantaneous trip function.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.5 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Temperature Rise: 125 / Class H Environment

E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor start and short circuit performance
G. Enclosure: Drip-proof.
H. Instrument Transformers: Mounted within generator enclosure.
I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
   1. Voltage regulation system shall be microprocessor controlled, 3-phase true RMS sensing, full wave rectified, and provide a pulse-width modulation signal to the exciter. No exceptions or deviations to these requirements will be permitted.
J. Alternator shall be provided with anti-condensation heater.
K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
L. Subtransient Reactance: 12 percent, maximum.

2.6 OUTDOOR GENERATOR-SET ENCLOSURE
A. Description: Vandal-resistant, weatherproof, sound attenuated steel housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments controls, and battery system shall be mounted within enclosure.
B. Construction:
   1. Louvers: Equipped with bird screen to permit air circulation when engine is not running while excluding birds and rodents.
   2. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
   3. Exhaust System:
      a. Muffler Location: Within enclosure.
   4. Hardware: All hardware and hinges shall be stainless steel.
   5. Wind Rating: Wind rating shall be 150 mph
   6. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
   7. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
C. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 85 dBA measured at any location 7 meters from the engine generator in a free field environment.
D. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

E. Provide and internally mounted and wired electrical distribution pnel to serve engine generator and enclosure; including:

1. 100 amp distribution panelboard connected to a 120/208VAC, single phase, 3 wire utility service by the installer.
2. Two duplex GFCI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure.
3. Factory wired normal AC service from the panelboard to the engine coolant heater, alternator heater, and battery charger.
4. Interior lights with switch: two three-way switches controlling three AC lamps mounted in vapor tight and gasketed fixtures.

F. Site Provisions:
1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.7 VIBRATION ISOLATION DEVICES

A. Vibration Isolators: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

B. FINISHES
1. Outdoor Enclosures and Components: Finish selection shall be by architect. Finishes for selection shall be from manufacturer's full catalog of UL finishes powder-coated and baked-over corrosion-resistant pretreatment and compatible primer.

2.8 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.
B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110.
B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
C. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
D. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
E. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.
F. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
G. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
H. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer’s recommended practice.

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 IDENTIFICATION

A. Identify system components according to Division 26 Section "Identification for Electrical Systems."

3.5 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. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
      a. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
      b. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test.
      c. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

E. Tests shall be conducted after Power Control System has been tested and approved for compliance.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Remove and replace malfunctioning units and retest as specified above.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

J. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 DEMONSTRATION

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

END OF SECTION 263213

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, LED’s and drivers.
   2. Exit signs.
   3. 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. Metal Parts: Free of burrs and sharp corners and edges.
C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
E. 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.
F. 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.

B. LED Downlights:
   1. Housing, LED driver and LED module shall be products of the same manufacturer.

C. Heat: Fixture housings shall be designed to transfer heat from the LED board to the outside environment.

D. 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.

E. 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.

F. Burn-In-Time: All LED fixtures (100% of each lot) shall undergo a minimum eight-hour burn-in test during manufacturing.

G. 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 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. Battery shall be capable of energizing fixture for a minimum of 90 minutes continuously.
      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 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

LIGHTING SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER	LAMP	WATTS	VOLTS	CONTROL	REMARKS	LOCATION
A1	RECESSED 2X2 FLAT PANEL WITH EDGE LIT LEDS, ALUMINUM BEZEL EDGE AND INTEGRAL 0-10V 10% DIMMING DRIVER.	METALUX 22FP 22FP2135C	3500K 2205 LM 80 CRI	20.7	120	0-10V		GENERAL
A2	SIMILAR TO TYPE A1 EXCEPT FIXTURE SHALL BE SUSPENDED, LUMEN OUTPUT SHALL BE REDUCED BY 50% AT FACTORY AND DIM TO 1%.	METALUX CGTX ETO144822-22CGTX-11-L835-HCD + MAX WATTAGE LABEL + FPSUS2-ML.	3500K 1100 LM 80 CRI	8.19	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF SOFFIT.	LIBRARY
A3	SIMILAR TO TYPE A1 EXCEPT FIXTURE SHALL BE 2X4.	METALUX 24FP 24FP4735C	3500K 4600 LM 80 CRI	41.4	120	0-10V		MUSIC STORAGE
B1	CABLE SUSPENDED INDIRECT/DIRECT PENDANT, 8.25"W x 1.75" H X 4'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, SOFTSHINE DIRECT OPTICS, BATWING INDIRECT DISTRIBUTION, FLAT END CAPS, WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	PEERLESS BRUNO BRM4L-LLP-4-MSL4-80CRI-35K-I700LMF-300LMF-MIN1-ZT-120-SCT-F1-48A-C210-MEZ	3500K IND:700 LMF DI: 300LMF 80 CRI	33.6	120	0-10V DIM	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 8'-0 A.F.F. (ARCH TO CONFIRM)	CLASS-ROOM
B2	SIMILAR TO TYPE B1 EXCEPT FOR FIXTURE SHALL BE 8'-0" LONG.	PEERLESS BRUNO BRM4L-LSL-8-MSL4-80CRI-35K-I700LMF-300LMF-MIN1-ZT-120-SCT-F1-48A-C210-MEZ	3500K IND: 700LMF DI: 300LMF 80 CRI	67.2	120	0-10V DIM	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 8'-0 A.F.F. (ARCH TO CONFIRM)	CLASS-ROOM
B3	SIMILAR TO TYPE B2 EXCEPT FOR FIXTURE SHALL BE 10'-0" LONG.	PEERLESS BRUNO BRM4L-LSL-10-MSL4-80CRI-35K-I700LMF-300LMF-MIN1-ZT-120-SCT-F1-48A-C210-MEZ	3500K IND: 700LMF DI: 300LMF 80 CRI	84	120	0-10V DIM	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 8'-0 A.F.F. (ARCH TO CONFIRM)	CLASS-ROOM
C1	NOT USED							
C2	RECESSED LINEAR SLOT, 6"W x 4.5"D X 6' -0" L WITH EXTRUDED ALUMINUM HOUSING, FLUSH FROSTED ACRYLIC LENS, WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	MARK LIGHTING SLOT 6 SL6L-LOP-6-FLP-TG-80CRI-35K-500LMF-MIN1-120-ZT	3500K 3000 LM 80 CRI	30	120	0-10V		CORRIDOR

D1	NOT USED							
D2	RECESSED 4.5" SQUARE APERTURE DOWNLIGHT WITH STEEL HOUSING, 95 DEGREE BEAM DISTRIBUTION, BOROSILICATE FROSTED LENS, WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	USAI LIGHTING PRIMARY BEVEL 2.2 P4SDF-15L2-35KS-F-WH-NC-UNV-D22-**MODIFICATION BF LENS**-SDA-FM	3500K 1300 LM 80 CRI	15	120	0-10V		LIBRARY
E1	RECESSED INDIRECTLY LIT 4X4 TROFFER WITH STEEL HOUSING, ACT TILE BACKING (PROVIDED BY CEILING TILE MANUFACTURER), WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	NULITE BOUNCE BRT4-44-60-L35-U-D-WH-ARMSTRONG OPTIMA 3256 3256 TEGULAR 4X4 FORMAT	3500K 6000 LM 80 CRI	60	120	0-10V DIM		LIBRARY
F1	SURFACE CEILING MOUNTED LUMINAIRE, 13" Ø X 5.5"H WITH SPUN METAL HOUSING, OPAL MATTE ACRYLIC, BRUSHED BRASS FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	SCOTT ARCHITECTURAL LIGHTING S7225-L12-35K-BB	3500K 1176 LM 80 CRI	12	120	0-10V		BATHROOM
F2	STEM MOUNTED PENDANT, 36" DIA. X 5" H WITH STEEL HOUSING, $\frac{1}{2}$" DROP LENS AND INTEGRAL 0-10V 1% DIMMING DRIVER. CUSTOM COLOR FINISH SHALL BE RAL 5002.	CORONET PRD 3FT DIRECT PRD-3-35-HIGH-UNV-DB-CC RAL 5002-PS-12-DL	3500K 6250 LM 80 CRI	76	120	0-10V DIM	TOP OF FIXTURE ALIGNS WITH BOTTOM OF SOFFIT.	ENTRY
G	RECESSED DOWNLIGHT, 4.5" Ø APERTURE WITH STEEL HOUSING, 35 DEG BEAM SPREAD, BOROSILICATE FROSTED LENS AND INTEGRAL 0-10V 1% DIMMING DRIVER.	USAI LIGHTING BEVELED 2.2 PRIMARY P4RDF-15L2-35KS-M-WH-NC-UNV-D22-**MODIFICATION BF LENS**-SDA-FM	3500K 1225 LM 80 CRI	15	120	0-10V		GENERAL
G2	SIMILAR TO G EXCEPT FOR MOUNTING.	USAI LIGHTING BEVELED 2.2 PRIMARY P4RDF-15L2-35KS-M-WH-NC-UNV-D22-**MODIFICATION BF LENS**-SDA-FM	3500K 1225 LM 80 CRI	15	120	0-10V		GENERAL
H1	RECESS MOUNTED LINEAR SLOT, 6" W X 4.5" D X 8'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, LAMBERTIAN DISTRIBUTION, FLUSH FROSTED ACRYLIC LENS, WHITE FINISH AND INTEGRAL 1% DIMMING DRIVER.	MARK LIGHTING SLOT 6 SL6L-LOP-8-FLP-FL-80CRI-35K-900LMF-MIN1-120-ZT	3500K 7200 LM 80 CRI	72	120	0-10V DIM		STAIR

H2	SIMILAR TO TYPE H1 EXCEPT CEILING SHALL BE ACT.	MARK LIGHTING SLOT 6 SL6L-LOP-8-FLP-TG-80CRI-35K-900LMF-MIN1-120-ZT	3500K 7200 LM 80 CRI	72	120	0-10V DIM		STAIR
H3	SIMILAR TO TYPE H1 EXCEPT FIXTURE SHALL BE 6'-0" LONG.	MARK LIGHTING SLOT 6 SL6L-LOP-6-FLP-FL-80CRI-35K-900LMF-MIN1-120-ZT	3500K 5400 LM 80 CRI	54	120	0-10V DIM		STAIR
H4	SIMILAR TO TYPE H2 EXCEPT FOR LUMEN OUTPUT.	MARK LIGHTING SLOT 6 SL6L-LOP-8-FLP-TG-80CRI-35K-1200LMF-MIN1-120-ZT	3500K 9600 LM 80 CRI	96	120	0-10V DIM		STAIR
H5	SIMILAR TO TYPE H1 EXCEPT FIXTURE SHALL BE SURFACE MOUNTED.	MARK LIGHTING SLOT 6 S6SD-LLP-8-FLP-80CRI-35K-900LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT	3500K 7200 LM 80 CRI	72	120	0-10V DIM		STAIR
H6	SIMILAR TO TYPE H5 EXCEPT FIXTURE SHALL BE 6'-0"L.	MARK LIGHTING SLOT 6 S6SD-LLP-6-FLP-80CRI-35K-900LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT	3500K 5400 LM 80 CRI	54	120	0-10V DIM		STAIR
H7	SIMILAR TO TYPE H1 EXCEPT FIXTURE SHALL BE SURFACE WALL MOUNTED.	MARK LIGHTING SLOT 4 S4WD-LLP-8-MSL8-80CRI-35K-1000LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT	3500K 8000 LM 80 CRI	64	120	0-10V DIM		STAIR
J1	PERIMETER MOUNTED LINEAR SLOT, 4" W X 4.5"H X LENGTH AS PER DWGS WITH EXTRUDED ALUMINUM HOUSING, LAMBERTIAN DISTRIBUTION, FLUSH FROSTED ACRYLIC LENS, WHITE FINISH AND INTEGRAL 1% DIMMING DRIVER.	MARK LIGHTING SLOT 4 SL4L-LOP-LENGTH AS PER DWGS-FLP-WFL-80CRI-35K-400LMF-MIN1-120-ZT	3500K 400 LMF 80 CRI	4W/LF	120	0-10V DIM	FIXTURE LENGTH SHALL BE A LINEAR FOOT NOMINAL LENGTH. FIXTURE SHALL BE CENTERED IN WALL LENGTH AND SHALL COME WITHIN 6" OF EITHER END. FIXTURE LENGTH IS AS PER DRAWINGS AND IN FIELD DIMENSIONS.	GENERAL
J2	SIMILAR TO TYPE J1 EXCEPT FOR WALLWASH DISTRIBUTION.	MARK LIGHTING SLOT 4 SL4L-LOP-LENGTH AS PER DWGS-FLP-FL-80CRI-35K-800LMF-WW-MIN1-120-ZT	3500K 800 LMF 80 CRI	8W/LF	120	0-10V	FIXTURE LENGTH SHALL BE A LINEAR FOOT NOMINAL LENGTH. FIXTURE SHALL BE CENTERED IN WALL LENGTH AND SHALL COME WITHIN 6" OF EITHER END. FIXTURE LENGTH IS AS PER DRAWINGS AND IN FIELD DIMENSIONS.	LIBRARY

J3	SIMILAR TO TYPE J2 EXCEPT FOR CEILING TYPE AND LUMEN OUTPUT.	MARK LIGHTING SLOT 4 SL4L-LOP-LENGTH AS PER DWGS-FLP-FL-80CRI-35K-600LMF-WW-MIN1-120-ZT	3500K 600 LMF 80 CRI	6W/LF	120	0-10V	FIXTURE LENGTH SHALL BE A LINEAR FOOT NOMINAL LENGTH. FIXTURE SHALL BE CENTERED IN WALL LENGTH AND SHALL COME WITHIN 6" OF EITHER END. FIXTURE LENGTH IS AS PER DRAWINGS AND IN FIELD DIMENSIONS.	GREEN ROOM
J4	SIMILAR TO TYPE J1 EXCEPT CEILING TYPE IS DRYWALL, FIXTURE SHALL BE RECESSED AND SHALL HAVE LIT 90 DEGREE CORNERS.	MARK LIGHTING SLOT 4 SL4L-LOP-LENGTH AND PATTERN AS PER DWGS-FLP-FL-80CRI-35K-400LMF-MIN1-120-ZT	3500K 400 LMF 80 CRI	4W/LF	120	0-10V		CAFETERIA, MUSIC ROOMS
K1	NOT USED							
K2	NOT USED							
L	CHAIN HUNG LINEAR STRIP, 3"W X 4"H X 8'-0 LONG WITH STEEL HOUSING, FULL FROSTED WIDE ROUNDED LENS, WHITE FINISH AND INTEGRAL 0-10V 10% DIMMING DRIVER.	METALUX SNLED 8TSNLED-LD5-95SL-LW-UNV-L835-CD-1-AYC/CHAIN/SET-(2)WG/SNF-4FT	3500K 9785 LM 80 CRI	82	120	0-10V	MOUNTING HEIGHT TO BE COORDINATED AROUND DUCTWORK. BOTTOM OF FIXTURE SHALL BE MOUNTED AT 9'-0" AFF.	BOH
M	SURFACE CORNER MOUNTED LINEAR STRIP, .75" SQ. X 4'-6" LONG WITH EXTUDED ALUMINUM HOUSING, CORNER ACRLYIC LENS, WHITE OPTICS, SATIN FINISH, STAINLESS STEEL CLIPS, DIFFUSED LENS AND INTEGRAL 0-10V 1% DIMMING DRIVER.	QTRAN TELA TELA-WO-ST-SST-DF-NI-4'-6", SW24/5.0-DRY-35-BW-BW-4'-6", QTM-eLED(E)	3500K 380 LMF 80 CRI	5W/LF	120	0-10V	FIXTURE SHALL BE CENTERED IN CASEWORK AND SHALL COME WITHIN 3" OF EITHER END. REMOTE DRIVER TO BE LOCATED IN A CLEAN, DRY, EASILY ACCESSIBLE LOCATION. EE AND EC TO COORDINATE. EE TO COORDINATE WIRING SIZE TO PREVENT VOLTAGE DROP.	DISPLAY CASE
N	CABLE SUSPENDED PENDANT, 18" DIA. APERTURE X 15.5"H WITH ALUMINUM HOUSING, FROSTED, TEMPERED LENS, ANODIZED FINISH AND INTEGRAL 0-10V 1% DRIVER.	DELRAY INDUSTRIAL IL7800-A-HO-W35-D-SM	3500K 5850 LM 80 CRI	56	120	0-10V	BOTTOM OF FIXTURE TO BE MOUNTED AT 12'-0" AFF (ARCH TO CONFIRM).	FITNESS

P	H90 HUB COMPONENT OF GO FIGURE 7	ALW GO FIGURE 7 H90 COMPONENT	N/A	N/A				CAFETERIA
P1	CABLE SUSPENDED LINEAR, 2"W X 1"H X 2'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, DIFFUSED LENS, BLACK FINISH, AND INTEGRAL 0-10V 1% DIMMING DRIVER. MANUFACTURER TO FACTORY SET LUMEN OUTPUT TO 400 DELIVERED LUMENS PER LINEAR FOOT AND PROVIDE MAXIMUM WATTAGE LABEL OF 7 WATTS PER LINEAR FOOT.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	14	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P2	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 3'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	21	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P3	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 4'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	28	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P4	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 4'-6" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	31.5	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P5	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 5'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	35	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P6	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 6'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	42	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA

P7	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 7'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	49	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P8	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 8'-0" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	56	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
P9	SIMILAR TO TYPE P1 EXCEPT FIXTURE LENGTH SHALL BE 3'-6" LONG.	ALW GO FIGURE 7 RPD07-LENGTH AND PATTERN PER DWGS-3500-0/10V/1%-TBD-UNV-**MODIFIED FOR 400LMF	3500K 400 LMF 80 CRI	24.5	120	0-10V DIM	MOUNTING HEIGHT OF 13'-0" AFF TO BE VERIFIED WITH ARCHITECT. ALLOW FOR 48" OF CABLE LENGTH.	CAFETERIA
Q1	SURFACE MOUNT LINEAR LENSED SLOT, 2.5"W X 4.75" H X 7'-8" LONG WITH EXTRUDED ALUMINUM HOUSING, EVENGLOW LENS, WHITE FINISH, INTEGRAL DAYLIGHT SENSOR AND INTEGRAL 0-10V 1% DIMMING	STARFIRE VERSALUX LED SD2-8-35-H-S-DF-80-DAYLIGHT SENSOR	3500K 4900 LM 80 CRI	49.6	120	0-10V DIM	FIXTURE SHALL BE POWERED THROUGH ENDS OF FIXTURE.	SKYLIGHT
Q2	RECESSED MOUNTED LENSED LINEAR, 6"W X 4.5"D X 4'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, LAMBERTIAN DISTRIBUTION, FLUSH FROSTED ACRYLIC LENS, WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	MARK LIGHTING SLOT 6 SL6L-LOP-4-FLP-TG-80CRI-35K-900LMF-MIN1-120-ZT	3500K 3600 LM 80 CRI	32	120	0-10V		SERVERY
Q3	NOT USED							
Q4	NOT USED							
R1	SURFACE WALL MOUNTED SCONCE, 11"WIDE X 5" HIGH X 2.5" DEEP WITH ALUMINUM HOUSING, SODA GLASS LIME LENS, TYPE 2 DISTRIBUTION, PHOTOCELL BUTTON, TEXTURED IRON GRAY FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	PERFORMANCE IN LIGHTING MIMIK 30 M30-18-T2-IG-35-UNV-010V-PHC-B-	3500K 1325 LM 80 CRI	18	120	0-10V	REFER TO ARCHITECT'S ELEVATIONS FOR MOUNTING HEIGHTS.	EXTERIOR ENTRY

R2	SURFACE WALL MOUNTED SCONCE, 3"DIA. X 48" H X 4" PROJECTION WITH CORROSION RESISTANT EXTRUDED ALUMINUM HOUSING, WHITE TRANSLUCENT IMPACT RESISTANT UV STABLIZED LENS, GUN METAL FINISH AND INTEGRAL 0-10V 10% DIMMING DRIVER.	LUMINIS LUMISTICK CL325-L112W20-120V -DGT-K35-MT4	3500K 1640 LM 80 CRI	20	120	0-10V		TERRACE
S	SURFACE WALL MOUNTED SCONCE, 11"WIDE X 5" HIGH X 2.5" DEEP WITH ALUMINUM HOUSING, SODA GLASS LIME LENS, TYPE 4 DISTRIBUTION, PHOTOCELL BUTTON, TEXTURED IRON GRAY FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	PERFORMANCE IN LIGHTING MIMIK 30 M30-36-T4-IG-35-UNV-010V-PHC-B-	3500K 2650 LM 80 CRI	36	120	0-10V		LOADING DOCK
T	CABLE SUSPENDED ACOUSTICAL INDIRECT/DIRECT PENDANT, 24"SQ. X 18"H WITH FELT SIDES, LAMBERTIAN DISTRIBUTION, FLUSH SPOTLESS LENSES AND INTEGRAL 0-10V 1% DIMMING DRIVER. FELT FINISH SHALL BE OCEAN WITH WHITE EDGE.	AXIS LIGHTING SPATIAL SOFTZONE SSZSF-SQ90-2-18-SLI-250-DSO -400-80-35-TBD-120-MD-1-CA48"-RC-C-OCE	3500K 2600 LM 80 CRI	26	120	0-10V	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 9'-0"AFF AND SHALL BE VERIFIED BEFORE INSTALLATION.	PRACTICE
U1	CABLE SUSPENDED LENSED LINEAR, 2.5"W X 3.75"H X 4'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, LAMBERTIAN DISTRIBUTION, FLUSH FROSTED ACRYLIC LENS, WHITE FINISH, SQUARE CANOPY AND INTEGRAL 0-10V 1% DIMMING DRIVER.	MARK LIGHTING SLOT 2 S2PD-LLP-4-MSL4-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQCY-BLKCY-BCRD	3500K 2188 LM 80 CRI	18.8	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	ORCHESTRA, CHORUS
U2	SIMILAR TO U1 EXCEPT FIXTURE SHALL BE 6'-0" LONG.	MARK LIGHTING SLOT 2 S2PD-LLP-6-MSL6-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQCY-BLKCY-BCRD	3500K 3282 LM 80 CRI	28.1	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	CHORUS, BAND
U3	CABLE SUSPENDED "L" SHAPED PENDANT, EACH "L" 3'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, LAMBERTIAN DISTRIBUTION, FLUSH FROSTED ACRYLIC LENS, 90 DEGREE LIT CORNER, BLACK FINISH, SQUARE CANOPY AND INTEGRAL 0-10V 1% DIMMING DRIVER.	MARK LIGHTING SLOT 2 S2PD-LLP-3-MSL3-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQDCY-BLKCY-BCRD	3500K 3282 LM 80 CRI	28.1	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	BAND

U4	SIMILAR TO U3 EXCEPT EACH "L" SHALL BE 6'-0" LONG.	MARK LIGHTING SLOT 2 S2PD-LLP-6-MSL6-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQDCY-BLKCY-BCRD	3500K 6564 LM 80 CRI	56.2	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	BAND
U5	SIMILAR TO U1 EXCEPT FIXTURE SHALL BE 3'-0" LONG.	MARK LIGHTING SLOT 2 S2PD-LLP-3-MSL3-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQDCY-BLKCY-BCRD	3500K 1641LM 80 CRI	14.1	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	BAND
U6	SIMILAR TO U1 EXCEPT FIXTURE SHALL BE 10'-0" LONG.	MARK LIGHTING SLOT 2 S2PD-LLP-5-MSL5-80CRI-35K-600LMF-SCT-MIN1-FLL-MVOLT-WHTT-ZT-F2-72A-SQDCY-BLKCY-BCRD	3500K 5470LM 80 CRI	46.8	120	0-10V	BOTTOM OF FIXTURE SHALL ALIGN WITH BOTTOM OF BAFFLE CEILING.	RECORDING STUDIO
V	STEM MOUNTED 18" DIA. DECORATIVE PENDANT WITH OPAL DIFFUSER, WHITE FINISH, AND INTEGRAL 0-10V 1% DIMMING DRIVER.	BASELITE OPAL BALL OB18-TBD-ST27-LSCNK-WH-25W-35K-LDM0-10V-	3500K 2800 LM 80 CRI	25	120	0-10V	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 9'-0" AFF AND SHALL BE VERIFIED BEFORE INSTALLATION.	GREEN ROOM
W	SURFACE WALL MOUNTED MARQUEE LUMINAIRE, 2"W X 4'-0" LONG WITH EXTRUDED ALUMINUM HOUSING, 6" ON CENTER LAMPING, LAMP GUARDS AND WHITE FINISH.	BELFER LIGHTING MQ 2502 MQ2502-6-WP-F-MQLG	LAMP: (8) GE RELAX HD LED 40 WATT, SOFT WHITE (2700K)	44	120	FORWARD PHASE	MOUNTING HEIGHT TO BE COORDINATED WITH ARCHITECT.	STAGE PREP
X	CABLE SUSPENDED DECORATIVE PENDANT, 36" DIA. X 8" HIGH WITH METAL BODY, METAL BELT, OPAL ACRYLIC BOTTOM DIFFUSER, SMOKEY BRASS FINISH, AND INTEGRAL 0-10V 1% DIMMING DRIVER. BELT SHALL BE BLACK PEARL.	ULTRALIGHTS INVICTA 16354-36-SB-04-BP-CABLE HUNG	3500K 12968 LM 80 CRI	82.6	120	0-10V	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 9'-0" AFF AND SHALL BE CONFIRMED BEFORE INSTALLATION.	AUD. LOBBY, GYM LOBBY
Y	STEM MOUNTED DECORATIVE PENDANT, 30" DIAMETER X 5.5"H WITH GOLD FINISH, OPAL MATTE ACRYLIC LENS AND INTEGRAL 0-10V 1% DIMMING DRIVER.	SCOTT ARCHITECTURAL LIGHTING S2A56-L60-35K-GT	3500K 6000 LM 80 CRI	60	120	0-10V	BOTTOM OF FIXTURE SHALL BE MOUNTED AT 9'-0" AFF AND SHALL BE CONFIRMED BEFORE INSTALLATION.	VESTIBULE

Z	RECESS MOUNTED 2X2 TROFFER WITH STEEL HOUSING, $\frac{1}{4}$" THICK ACRYLIC FROSTED WITH POLYCARBONATE CLEAR LENS, WHITE FINISH AND INTEGRAL 0-10V 1% DIMMING DRIVER.	LITHONIA 2VRTL-G-L24-7000LM-ICW-AP250FL-MVOLT-EZ1-35K-80CRI-WH	3500K 6357 LM 80 CRI	60.6	120	0-10V		GYM

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.

2.5 POLE ACCESSORIES

F. 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 280513 - CONDUCTORS AND CABLES 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. Fire alarm wire and cable.
   2. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.
B. EMI: Electromagnetic interference.
C. IDC: Insulation displacement connector.
D. 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.
E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
F. 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. Cable Trays:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit; a business unit of Tyco Electrical & Metal Products.
      b. Cablofil.
      c. Cooper B-Line, Inc.
   2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick.
      a. Basket Cable Trays: 6 inches wide and 2 inches deep. Wire mesh spacing shall not exceed 2 by 4 inches.
      b. Trough Cable Trays: Nominally 6 inches wide.
      c. Ladder Cable Trays: Nominally 12 inches wide, and a rung spacing of 12 inches.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. 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, [provide products by one of the following] [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. Install wiring in metal raceways and wireways. Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 3/4 inch.

B. 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.

C. Install cable, concealed in accessible ceilings, walls, and floors when possible.

D. 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."
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, raceways 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 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 28.

1.3 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”.

1.4 SUMMARY

A. This Section includes requirements for commissioning the digital, addressable fire alarm system.

1.5 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.

1.6 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.

1.7 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 Enlarged City School District of Middletown.

1.8 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.

1.9 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. Fire-alarm control unit
   2. Manual fire-alarm boxes
   3. System smoke detectors
   4. Carbon monoxide detectors
   5. Heat Detectors
   6. Notification Appliances
   7. Remote annunciator
   8. Addressable interface device
   9. Digital alarm communicator transmitter

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.
   2. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
      a. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
      b. Include voltage drop calculations for notification appliance circuits.
      c. Include battery-size calculations.
      d. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
      e. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. 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.
      e. Manufacturer's required maintenance related to system warranty requirements.

D. 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

1. 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:
   a. Notify Owner and Construction Manager no fewer than 7 days in advance of proposed interruption of fire-alarm service.
   b. 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. 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. Edwards Life Safety and Incident Management
2. Notifier; a Honeywell company
3. Fire Light Alarms; a Honeywell company
4. Siemens Building Technologies, Inc.

2.2 SYSTEMS OPERATIONAL DESCRIPTION
A. Fire-alarm signal initiation shall be by one or more of the following devices and s systems:
1. Manual stations.
2. Heat detectors.
3. Smoke detectors.

4. Duct smoke detectors.

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. 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. 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. General Requirements for Fire-Alarm Control Unit:
   1. UL-certified addressable system, with multiplexed signal transmission and voice-and-strobe notification evacuation.
   2. Addressable initiation devices that communicate device identity and status.
      a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
      b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
   3. Addressable control circuits for operation of mechanical equipment.

B. Power Supply
   1. Primary Power: Supervised power limited 24VDC obtained from 120VAC as required by the panel and external loads fed by the panel. Initial power supply loading shall not exceed 80% of power supply capacity.
   2. Secondary Power: 24VDC supply system with batteries, automatic battery charger, and automatic transfer switch.

3. Each power supply shall be individually supervised and display trouble signal with the nature of the trouble condition.
4. Upon failure of normal power, the affected portion shall automatically switch over to secondary power without losing any system functionality.
5. All standby batteries shall be continuously monitored by power supply. Batteries shall utilize sealed lead acid chemistry. Initial battery capacity shall provide 125% of calculated capacity requirements in order to allow for future system expansion.

C. User Interface
1. Audio Annunciation and Control
   a. Provide emergency audio notification panel as an addition to the existing fire alarm control. The emergency audio shall contain a paging microphone, pre-recorded messages and zoned amplifiers capable of delivering multi-channel audio messages.
   b. During non-alarm conditions, each panel shall supervise its amplifiers, inter-panel networking shall be supervised and audio hardware shall be supervised providing total audio path supervision.
   c. Each FACP containing an audio amplifier or audio source connection shall contain its locally required pre-recorded messaging onboard
2. Paging Microphone
   a. Paging microphone shall be included in emergency audio notification unit as indicated on drawings.
   b. Paging microphone shall facilitate live page announcements over fire-alarm control unit system.

D. Circuits
1. Signaling Line Circuits (SLC)
   a. The signaling line circuit connecting panels/nodes to intelligent addressable devices including, detectors, monitor modules, control modules, isolation modules and notification circuit modules shall be Class B. All signaling line circuits shall be supervised and power limited.
   b. Each SLC shall support 125 addressable detector addresses and 125 module addresses. Initial circuit loading shall not exceed 80% in order to allow for future system expansion.
   c. The SLC module shall allow replacement of “same type” devices without the need to address and reload the “location” parameters on replacement devices.
   d. The SLC/Panels shall notify the user when un-programmed devices are detected on the SLC circuit. The SLC/Panels shall notify the user when the wrong device type is installed at a location configured for a different device type on the SLC circuit.
2. Notification Appliance Circuits (NAC)
   a. All notification circuits shall be supervised and power limited. Non-power limited circuits are not acceptable. All notification appliance circuits shall be Class B. Initial circuit loading shall not exceed 80% in order to allow for future system expansion.
   b. Notification appliance circuits shall have a minimum circuit output rating of 3 amps @ 24 VDC.

c. Audio notification appliance circuits shall be polarized and have a minimum circuit output rating of 50 watts @ 25V audio, and 35 watts @ 70V audio.

3. Audio Amplifiers

a. Provide emergency audio as part of the emergency audio notification unit. The emergency audio shall contain a paging microphone and zoned amplifiers capable of delivering multi-channel audio messages.

b. The audio system zoned amplifiers must be able to operate 25 VRMS or 70 VRMS speakers and be power limited and protected from short circuit conditions on the audio circuit. The amplifier output must be power limited, and wired in a Class B configuration. The amplifiers shall source pre-recorded messages locally, and shall not have to rely on network communications to receive pre-recorded messaging. Should local audio be unavailable the amplifiers shall provide an integral backup 1000 Hz temporal (3-3-3) tone generator evacuation notification and 20PPM for alert notification which shall operate in the event primary audio signals are lost and the amplifier is instructed to broadcast alarm information.

c. Provide a standby audio amplifier that shall automatically sense the failure of a primary amplifier, and automatically program themselves to select and de-multiplex the same audio information channel of the failed primary amplifier, and fully replace the function of the failed amplifier.

d. Amplifiers shall also include a 24 VDC notification appliance circuit rated at 24Vdc @ 3.5A for connection of visible (strobe) appliances. This circuit shall be fully programmable.

e. Initial amplifier loading shall not exceed 80% in order to allow for future system expansion. Calculations shall assume each speaker is connected at one (1) watt.

E. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.

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.

2.5 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. Provide with clear plastic enclosure hinged at top.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
3. 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.
4. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
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. Weatherproof housing shall be installed on all duct smoke detectors installed on exterior mounted ducts.
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.

2.7 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.

2.8 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.
1. 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.
2. Mounting: Twist-lock base interchangeable with smoke-detector bases.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.9 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.

2.10 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
   1. Mounting: Surface cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.11 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.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACTs)

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.
B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
C. Local functions and display at the digital alarm communicator transmitter shall include the following:
   1. Verification that both telephone lines are available.
   2. Programming device.
   3. LED display.
   4. Manual test report function and manual transmission clear indication.
   5. Communications failure with the central station or fire-alarm control unit.
D. Digital data transmission shall include the following:
   1. Retain applicable subparagraphs below; revise to match characteristics of fire-alarm control unit and requirements of the central station.
   2. Address of the alarm-initiating device.
   3. Address of the supervisory signal.
   4. Address of the trouble-initiating device.
   5. Loss of ac supply or loss of power.
   6. Low battery.
   7. Abnormal test signal.
   8. Communication bus failure.
E. Secondary Power: Integral rechargeable battery and automatic charger.
F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

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. 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.
   4. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
   5. 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 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.
   a. 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.
   b. Test audible appliances for the private operating mode according to manufacturer's written instructions.
   c. Test visible appliances for the public operating mode according to manufacturer's written instructions.
   d. 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 311000 – SITE CLEARING

PART 1-GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Division 01 General Requirements and Section 01 50 00 Temporary Facilities and Controls apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities or abandoning site utilities in place.
7. Temporary erosion and sedimentation control measures.

1.3 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain on the Site, cleared materials shall become Contractor's property and shall be removed from the Site.

1.5 SUBMITTALS

A. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations per applicable Highway Permits, Division 01 General Requirements, and Drawings.

B. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

C. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

D. Do not direct vehicle or equipment exhaust towards protection zones.

E. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

F. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2-PRODUCTS

2.0 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3-EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag each tree trunk at 54 inches (1372 mm) above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide in accordance with Drawings and Section 01 50 00 Temporary Facilities and Controls.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to Drawings.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.

3.4 EXISTING UTILITIES

A. Contractor (with consent of owner) shall arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and/or remove stumps, roots, obstructions, and debris to a depth of 24 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Top soil material shall be screened to be 1” minus and stockpiled onsite. Topsoil shall be in accordance with Section 2.2 of Turfs and Grasses Section 32 92 00

D. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches, unless otherwise authorized by Engineer.
2. Do not stockpile topsoil within protection zones.
3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off the Site.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 –EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Division 01 General Requirements and Section 01 50 00 Temporary Facilities and Controls apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for curbs, walks, pavements, lawns, and plantings.
2. Excavating and backfilling for stormwater practices and utility structures.
3. Subbase course for concrete walks and pavements.
4. Excavating and backfilling trenches for buried utilities and pits for buried utility structures.
5. Excavation for mass grading of site.

1.3 DEFINITIONS

A. Backfill: Soil materials used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.

C. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

D. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by Engineer.
2. Bulk Excavation: Excavations more than 10 feet (3 m) in width and pits more than 30 feet (9 m) in either length or width.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

E. Fill: Soil materials used to raise existing grades.

1. Rock: Rock material in beds, ledges, unstratified masses, and conglomerate deposits and boulders of rock material exceeding 1 cu. yd. (0.76 cu. m) in place that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted. Excavation of Trenches and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-(1065-mm-) wide, short-tip-radius rock bucket; rated at not less than 120-hp (89-kW) flywheel power with bucket-curling force of not less than 25,000 lbf (111 kN) and stick-crowd force of not less than 18,700 lbf (83 kN); measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp (157- kW) flywheel power and developing a minimum of 45,000-lbf (200-kN) breakout force; measured according to SAE J-732.

F. Structures: Slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

G. Subbase Course: Layer placed between the subgrade and asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

H. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

I. Utilities: include on-site underground pipes, conduits, ducts, and cables, as well as underground services within 5 feet of the building.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Each type of detectable warning tape.
2. Drainage fabric.
3. Separation fabric.

B. Blasting plan approved by authorities having jurisdiction, for record purposes.

1.5 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be re- moved. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not avail- able from excavations.

B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: ASTM D 2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT, or a combination of these group symbols.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Backfill and Fill: Satisfactory soil materials.

E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; meeting the requirements of NYSDOT Item # 304.12.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Crushed Stone: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; meeting the requirements of NYSDOT Item # 623.12 and gradation requirements of NYSDOT Item # 605.0901.

I. Rip Rap: Medium stone fill of crushed or uncrushed rock meeting the requirements of NYSDOT Item # 620.04, unless otherwise specified on the Drawings.

J. Bank Run Gravel: Naturally graded mixture of natural sand or sand and gravel, meeting ASTMD 2487 Soil Classification Groups GW, GP, or GM (Gravelly Soils), or SW, SP, or SM (Sandy Soils).

K. Controlled Fill: Refer to pages 5 through 8 of the Geotechnical Report prepared by Gifford Associates, dated October 2018 for specifications for Controlled Fill.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

B. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 110 lbf (490 N); ASTM D 4632.
2. Tear Strength: 40 lbf (178 N); ASTM D 4533.
3. Puncture Resistance: 50 lbf (222 N); ASTM D 4833.
4. Water Flow Rate: 150 gpm per sq. ft. (100 L/s per sq. m); ASTM D 4491.
5. Apparent Opening Size: No. 50 (0.3 mm); ASTM D 4751.

C. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum proper- ties determined according to ASTM D 4759 and referenced standard test methods:

1. Grab Tensile Strength: 200 lbf (890 N); ASTM D 4632.
2. Tear Strength: 75 lbf (333 N); ASTM D 4533.
3. Puncture Resistance: 90 lbf (400 N); ASTM D 4833.
4. Water Flow Rate: 4 gpm per sq. ft. (2.7 L/s per sq. m); ASTM D 4491.
5. Apparent Opening Size: No. 30 (0.6 mm); ASTM D 4751.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and waterways.

3.2 DEWATERING

A. Provide in accordance with Section 01 50 00 Temporary Facilities and Controls.

3.3 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of sur- face and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.4 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Equipment Pads: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or mi- nus 1 inch (25 mm). Do not disturb bottom of excavations intended for bearing surface.

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated cross sections, elevations, and grades.

3.6 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.

1. Clearance: As indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches (150 mm) in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with tamped sand backfill.
3. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.7 APPROVAL OF SUBGRADE

A. Notify Engineer when excavations have reached required subgrade.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.8 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.9 STORAGE OF SOIL MATERIALS

A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to pre- vent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
2. Soil material shall be screened to be 3” minus and stockpiled on site. Soil material shall be in accordance with section 2.1 of Earth Moving 31 20 00.
3. Top soil material shall be screened to be 1” minus and stockpiled onsite. Topsoil shall be in accordance with Section 2.2 of Turfs and Grasses Section 32 92 00.

3.10 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for record documents.
3. Inspecting and testing underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

3.11 UTILITY TRENCH BACKFILL

A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fit- tings, and bodies of conduits.

B. Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings; fill with concrete to elevation of bottom of footings.

C. Place and compact initial backfill of subbase material, free of particles larger than 1 inch (25 mm), to a height of 12 inches (300 mm) over the utility pipe or conduit.

1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of utility system.

D. Coordinate backfilling with utilities testing.

E. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is re- moved.

F. Place and compact final backfill of satisfactory soil material to final subgrade.

G. Install warning tape directly above utilities, 18 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.12 FILL

A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal, so fill material will bond with existing material.

C. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.

3.13 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under utility structures and paved shoulders, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill material at 92 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches (150 mm) below sub- grade and compact each layer of backfill or fill material at 90 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch (25 mm).
2. Walks: Plus or minus 1 inch (25 mm).
3. Pavements: Plus or minus 1/2 inch (13 mm).

3.16 SUBBASE AND BASE COURSES

A. Under pavements and walks, place subbase course on prepared subgrade and as follows:

1. Place base course material over subbase.
2. Compact subbase and base courses at optimum moisture content to required

grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3. Shape subbase and base to required crown elevations and cross-slope grades.
4. When thickness of compacted subbase or base course is 6 inches (150 mm) or less, place materials in a single layer.
5. When thickness of compacted subbase or base course exceeds 6 inches (150 mm), place materials in equal layers, with no layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick when compacted.

B. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area, but in no case fewer than three tests.
2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet (46 m) or less of trench length, but no fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, back- fill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil offsite.

1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dis- pose of it offsite.

END OF SECTION 312000

SECTION 312001 - EARTH MOVING FOR PLAY AREA WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Clearing and grubbing.
B. Removal of topsoil.
C. Underground utilities.
D. Excavation.
E. Rock excavation and blasting.
F. Dewatering.
G. Settlement detection.
H. Sheeting, shoring and bracing.
I. Placing engineering fabric.
J. Placing fill and backfill.
K. Placing fill to support structures.
L. Compaction.
M. Rough grading.
N. Subgrade surface for walks and pavement.
O. Finish grading.
P. Subgrade and base preparation for synthetic grass surfacing.
Q. Maintenance and restoration.
R. Disposal of excess and unsuitable materials.
S. Field quality control.
T. Protection.

1.2 RELATED SECTIONS

A. Section 023000 – Subsurface Investigations
B. Section 024113 – Selective Site Demolition
C. Section 321217 – Asphalt Paving for Play Area Work
D. Section 321314 – Concrete Paving for Play Area Work
E. Section 321813 – Synthetic Grass Surfacing
F. Section 329200 – Turf and Grasses

1.3 DEFINITIONS

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

1. Excavation - The removal of all surface and subsurface material not classified as rock (as defined below).
2. Rock - Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.5 cubic yards.
   a. Materials which can be loosened with a pick or backhoe, frozen materials, soft laminated shale or hardpan, pavements, curbs, and similar materials shall be classified as earth excavation. Concrete building foundations and

concrete slabs, where indicated, shall be classified as earth excavation. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

3. Unclassified Earth Excavation - The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this Contract. These materials shall include:

   a. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.
   b. Ledge rock of all quality including limestone, sandstone, shale, granite and similar materials in solid beds or masses in its original or stratified position which can only be removed by drilling, wedging, use of pneumatic tools or heavy ripping equipment. Blasting operations will not be permitted to loosen any ledge rock necessary to be removed in this Contract without prior written permission from the Project Designer and the Owner's Representative.
   c. Boulders of any size.
   d. Any materials of man-made origin.

4. Subgrade Surface - Surface upon which gravel base or topsoil is placed.
5. Base - Select granular material or Type 1 and Type 2 base course which is placed immediately beneath pavement or concrete slabs.
6. Fill - Placement of specified fill materials, in layers, above ground surface to required elevations.
7. Backfill - Placement of specified backfill material, in layers, in excavations to required subgrade elevations.
8. Foundation Bearing Grade – Grade or elevation at which bottom of footings is to be constructed.
9. Maximum Density - The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).
10. Structures - Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
11. Landscaped Areas - Areas not covered by structures, walks, roads, paving, or parking.
12. Unauthorized Excavation - The removal of material below required elevations indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.

1.4 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data - Submit manufacturer's name, specifications and installation instructions as applicable for each item specified.

C. Samples - At the Owner's discretion, take samples in the presence of the Owner's Representative, and submit to the Owner's Independent Testing Laboratory for analysis. Test for gradation, proctors and soundness shall be completed with results submitted to the Owner's Designated Representatives. Tests shall be performed in accordance with ASTM standards, shall be performed and signed by a certified soils laboratory, and shall be submitted as part of the original submittal. At a minimum, unless agreed to differently, the samples taken shall be of the following quantities:

1. Select Type 1 Granular Material - 40 to 50 lbs.
2. Type 2 Base Course - 40 to 50 lbs.
3. Drainage Fill – 40 to 50 lbs, mixed to specification.
4. Synthetic Turf Dynamic Base - 40 to 50 lbs. of each required gradation.
5. Engineering Fabric - 12" X 12" sample.

D. Quality Control Submittals – Provide documentation complying with the following:

1. Base Materials - Name and location of source with the D.O.T. Source Number. If the material is not being taken from an approved D.O.T. source, the results of the gradation and soundness tests performed by an ASTM certified soils laboratory will be required.
2. Other Aggregates - Name and location of source and soil laboratory test results.
3. Excavation Procedure - Submit a lay out drawing or detailed outline of intended excavation procedure for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of intended excavation methods.
4. Sheeting, Shoring, and Bracing (Not shown on the Drawings) - Submit a detailed plan of intended sheeting, shoring and bracing, signed by a New York State Licensed Professional Engineer, for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of the intended sheeting, shoring and bracing methods.

E. Closeout Procedures - Comply with the requirements of Section 017700.

1.5 QUALITY ASSURANCE

A. General - The systems listed reflect the intent to establish required earthwork function and standard of quality for construction.

1.6 PROJECT CONDITIONS

A. Field Measurements - Establish and maintain required lines and elevations for grade control.

B. Protect existing trees and plants during performance of the Work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated

material or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.

C. Cold Weather Requirements – Comply with the following:

1. Excavation - When freezing temperatures are anticipated, do not excavate to final design elevations for concrete work unless concrete can be placed immediately.
2. Backfilling - If backfill is being placed during freezing temperatures, the backfilling operations shall be monitored by the Owner's Representative and the following procedures shall be followed:

    a. Frozen ground shall be removed in its entirety from beneath and five (5) feet beyond the area of fill placement.
    b. Fill material placed shall consist of Select Fill and shall be free of all frozen chunks that exceed four (4) inches in size. Material transported to the project site shall only consist of material excavated from below frost depth.
    c. At the end of the workday, the area of fill placement shall be covered with insulated blankets or left protected. Other means of protection (hay, wood chips etc.) may also be used provided it is approved by the Owner's Representative.
    d. Following workday - Remove insulated blankets or other approved protection methods and strip the area of all frozen material as specified previously.
    e. Upon establishing subgrade elevations, protect grades with insulated blankets or place additional material that will adequately insulate the exposed earth surface from frost. This additional fill or protective material shall be stripped just prior to pouring concrete.

D. Subsurface Information/Site Investigation Reports - Site investigation reports including soil boring logs and similar data included in the Construction Documents are intended to represent only conditions found at locations indicated at the time investigations were conducted. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or of continuity of such conditions. The Owner will not be responsible for interpretation or conclusions drawn there from by the Contractor.

1. The Contractor may perform additional test borings and other exploratory operations at no additional cost to the Owner upon approval of the Owner's Representative.

E. Land Survey Information - Field verify provided existing boundary and topographic information prior to beginning site work. Immediately report any discrepancies in boundary locations or topographic elevations affecting site construction to the Owner's Representative. Provide profile information on existing site conditions and verification of existing topographic information to the Owner's Representative prior to beginning site construction. Beginning site work construction without this profile information and written notification indicates the Contractor's acceptance of the existing land survey data indicated on the

Drawings as accurate. Adjustments to the Contract will not be made for discrepancies brought to the Owner's attention after site construction has begun.

1.7 SEQUENCING AND SCHEDULING

A. Proceed with, and complete earth moving operations as rapidly as portions of the work area become available, working within seasonal limitations for the tasks required.

PART 2 PRODUCTS

2.1 MATERIALS

A. Select Type 1 Granular Material: Where indicated, supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
3 inch	76.2	100
2 inch	50.8	90-100
1/4 inch	6.35	30-65
No. 40	0.425	5-40
No. 200	0.075	0-10

B. Base Course Type 2 Crushed Stone: Where indicated, supply stockpiled, crushed ledge rock or approved blast furnace slag. Comply with New York State Department of transportation gradation and material requirements modified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
2 inch	50.8	100
1/4 inch	6.35	25-60
No. 40	0.425	5-40
No. 200	0.075	0-7

C. Drainage Fill: Equal blend of No.1 and No. 2 washed crushed or uncrushed stone.

a. No. 1 Coarse Aggregate:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.4	100
½ inch	12.7	90-100
¼ inch	6.35	0-15

b. No. 2 Coarse Aggregate:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	38.1	100
1 inch	25.4	90-100
½ inch	12.7	0-15

D. Dynamic Base for Synthetic Grass Surfacing: refer to Section 321813 for additional information.

Sieve		Percent Passing	
Sieve Size	Sieve Size (mm)	Base Stone	Finishing Stone
2 inch	50.8	100	
1 ½ inch	38.1	90-100	
1 inch	25.4	75-100	
¾ inch	19.05	65-95	
½ inch	12.7	55-85	100
3/8 inch	9.53	40-75	85-100
¼ inch	6.35	25-65	75-100
No. 4 Sieve	4.76	15-60	60-90
No. 8 Sieve	2.38	0-40	35-75
No. 16 Sieve	1.191	0-20	10-55
No. 30 Sieve	0.594	0-7	0-40
No. 60 Sieve	0.249	0-5	0-15
No. 100 Sieve	0.150	0-3	0-8
No. 200 Sieve	0.075	0-2	0-2

1. Restrictions

a. To Ensure structural Stability: $D_{60}/D_{10} > 5$ and $1 < D^2_{30}/D_{10}\ D_{60} < 3$. Fragmentation must be 100 percent.

b. To Ensure Separation Of Both Stones: D_{85} of finishing stone / D_{15} of base stone > 2 and $3 < D_{50}$ of base stone / D_{50} of finishing stone < 6

c. To Ensure Proper Drainage:

1) Permeability of base stone > 500 in/hr (3.5×10^{-1} cm/sec)
2) Permeability of finishing stone > 20 in/hr (1.4×10^{-2} cm/sec)
3) Porosity of both stones > 25% (When stone is saturated & compacted to 95% Proctor.

4) "D_x" in preceding subparagraphs = Size of sieve (in mm) that lets pass x percent of stone. For example, D_{60} = size of sieve that lets 60 percent of stone pass. For calculation purposes, sizes may be obtained by interpolation on semi-log graph of sieve analysis.

d. Depending on type of rock present in crushed stone mix, other mechanical characteristics may be necessary for approval.

e. Where field supports heavy vehicles, give consideration for load bearing requirements of base.

E. Engineering Fabric: Fabric composed of high tenacity polypropylene yarns woven into a stable network. The fabric is to be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Min. Average Roll Value
Wide Width Tensile Strength	ASTM D 4595	kN/m m^2	MD 17.6 (100)/CD 21.0 (120)
Grab Tensile Strength	ASTM D 4632	kN (lbs)	MD 0.9 (200)/ CD 0.9 (200)
Grab Tensile Elongation	ASTM D 4632	%	MD 15/CD 10
Trapezoid Tear Strength	ASTM D 4533	kN (lbs)	MD 0.33 (75)/CD 0.33 (75)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2756 (400)
Puncture Strength	ASTM D 4833	kN (lbs)	0.4 (90)
Percent Open Area	COE-02215-86	%	1
Apparent Opening Size (AOS)	ASTM D 4751	mm (US Sieve	0.300 (50)
Permittivity	ASTM D 4491	sec^{-1}	0.05
Flow Rate	ASTM D 4491	l/min/m^2 (gal/min/ft^2)	200 (5.0)
UV Resistance (at 500 Hours)	ASTM D 4355	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m^2 (oz/ydm^2)	136 (4.0)
Thickness	ASTM D 5199	mm (mils)	0.51 (20)
Roll Dimensions (Width X Length)	-----	m (ft)	3.8 X 132 or 5.3 X 94.2 (12.5 X 432) or (17.5 X 309)
Roll Area	-----	m2 (yd2)	502 (600)
Estimated Roll Weight	-----	kg (lb)	95 (210)

1. Manufacturer: For convenience, details have been based on Mirafi 500X as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

F. Engineering Fabric for Synthetic Grass Surface: Non-woven geotextile fabric composed of polypropylene fibers formed into a stable network such that the

fibers retain their relative position. The fabric is to be inert to biological degradation, resisting naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum. Average Roll Value
Grab Tensile Strength	ASTM D 4632-91	kN (lbs)	MD 0.53 (120)/ CD 0.53 (120)
Grab Tensile Elongation	ASTM D 4632-91	%	MD 50/CD 50
Trapezoid Tear Strength	ASTM D 4533-91	kN (lbs)	MD 0.22 (50)/CD 0.22 (50)
Mullen Burst Strength	ASTM D 3786-87	kPa (psi)	1550 (225)
Puncture Strength	ASTM D 4833-00	kN (lbs)	0.3 (65)
Apparent Opening Size (AOS)	ASTM D 4751-99A	mm (US Sieve)	0.212 (70)
Permittivity	ASTM D 4491-99A	sec^{-1}	1.8
Permeability	ASTM D 4491-99A	cm/sec^{-1}	0.21
Flow Rate	ASTM D 4491-99A	$l/min/m^2$ ($gal/min/ft^2$)	5500 (135)
UV Resistance (at 500 Hours)	ASTM D 4355-02	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m^2 (oz/ydm^2)	163 (4.8)
Thickness	ASTM D 5199	mm (mils)	1.4 (55)
Roll Dimensions (Width X Length)	-----	m (ft)	3.8 X 110 or 4.5 X 110 (12.5 X 360) or (15 X 360)
Roll Area	-----	m2 (yd2)	502 (600)
Estimated Roll Weight	-----	kg (lb)	89 (197)

1. For convenience, details have been based on Mirafi 140N as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions - Examine conditions under which earthwork is to be accomplished with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the Installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the Installer.

3.2 PREPARATION

A. Protection

1. Use of explosives: Do not bring explosives onto the site or use on the project without prior written permission from the Architect and the Owner's Representative. The Contractor remains solely responsible for the handling, storage and use of explosive materials when permitted. Use explosives in strict compliance with State, Local and OSHA regulations.
2. Protection of Persons and Property:

   a. Barricade open excavations and post with warning lights for safety of persons. Operate warning lights during hours from dusk to dawn each day.
   b. Protect structures, utilities, sidewalks, pavements and other facilities immediately adjacent to excavations from damage caused by settlement, lateral movement, undermining, washout and other hazards.
   c. Take precautions and provide necessary bracing and shoring to guard against movement and settlement of existing improvements or new construction. Contractor remains entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by lack of adequate protection or by movement or settlement.

3.3 CLEARING AND GRUBBING

A. Clear and grub the site within the grading limit lines of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.

1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching

B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.

3.4 REMOVAL OF TOPSOIL

A. Remove existing topsoil from areas within the grading limit lines where excavation or fill is required.

B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.

1. Topsoil shall be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.5 UNDERGROUND UTILITIES

A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.

B. Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.

C. Utilities to remain in service shall be re-routed as shown on the Contract Drawings.

D. Utilities abandoned beneath and five (5) feet laterally beyond a structure's proposed footprint shall be removed in their entirety. Excavations required for their removal shall be backfilled and compacted as specified herein.

E. Unless otherwise noted in the Contract Documents, utilities extending outside the limit specified above (5 feet) may be abandoned in place provided their ends are adequately plugged as described below.

1. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
2. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for type of material and size of pipe. Do not use wood plugs.
3. Close open ends of concrete and masonry utilities with concrete or flow-able fill.

F. Coordinate with other Prime Contractors or with local utility companies, as applicable, for shutoff service if lines are active.

G. Coordinate scheduling of removal to accommodate relocation of lines when necessary.

H. Demolish and remove or relocate additional uncharted underground utilities conflicting with construction operations as directed by the Architect. Measure additional removal and relocations as directed by the Architect and paid for by the Owner as a Change Order.

3.6 EXCAVATION

A. Excavate earth as required for the work. Remove and dispose of all materials encountered to obtain required subgrade elevations. Remove from property and legally dispose of all excess fill material.

B. Install and maintain all erosion and sedimentation controls during all earthwork operations as directed by local officials.

C. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).

   1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

D. Stockpile excavated materials classified as suitable material where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage as approved by the Owner's Representative.

E. Excavation for Structures - Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1". Extend excavation a sufficient lateral distance to provide clearance to execute the work.

F. Footings and Foundations - The foundation bearing grade shall be established just prior to constructing concrete foundations when concrete is to bear on undisturbed soil.

G. Slabs - Excavate to the following depths below bottom of concrete for addition of select granular material:

   1. Exterior Slabs and Steps – 12" unless otherwise indicated.

H. Open Ditches - Cut ditches to cross sections and grades indicated.

I. Pavement - Excavate to subgrade surface elevation.

J. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular Type 1 material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Owner's Representative.

   1. Unauthorized excavations under structural work such as footings, foundation bases, and retaining walls shall be reported immediately to the Owner's Representative before any concrete or backfilling work commences.

K. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved.

L. Removal of Unsuitable Material Beneath Structures and Other Improvements - Excavate encountered unsuitable materials which extend below required

elevations to additional depth as directed by the Owner's Representative. Have cross sections taken, under the supervision of an independent Land Surveyor, to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.

M. Such additional excavation and backfilling, not due to error, fault or neglect of the Contractor and exceeding the numeric quantities indicated on the Drawings, will be paid for at a pre-negotiated or pre-established unit price by Change Order.

3.7 ROCK EXCAVATION AND BLASTING

A. Excavation - Consists of the removal and disposal of materials encountered that cannot be excavated with a 1½ cubic yard capacity power shovel without drilling and blasting, or requiring use of specialized equipment.

1. Typical Rock Classified Materials: Boulders 1½ cubic yards or more in volume, solid rock, rock in ledges, and rock hard cementitious aggregate deposits.

a. The Contractor shall classify intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered as earth excavation.

2. Rock payment lines shall be limited to the following:

a. Two feet outside of concrete work for which forms are required, except footings.
b. One foot outside of perimeter footings.
c. In pipe trenches, six inches below invert elevations of pipes and two feet wider than the inside diameter of the pipe, but not less than three foot minimum trench width.
d. Neat outside dimensions of concrete work where no forms are required.
e. Under slabs on grade, six inches below bottom of concrete slab.

B. Blasting - Perform blasting operations using skilled personnel, in compliance with governing regulations. Comply with ANSI A10.1 "Safety Code for Building Construction".

1. Store explosives, if permitted on the Owner's property, only where directed by the Owner's Representative and in proper storage structures. Keep storage facilities securely locked at all times for inspection and for delivery and storage of explosives. Provide full time watchman and other controls as required by governing regulations.
2. Conduct blasting operations using explosives of such quantity and power, and fired in such sequence and locations, to avoid injury to personnel or damage to property or adjacent construction. Assume full responsibility for damages resulting from or attributable to blasting operations.

3.8 DEWATERING

A. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.

B. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

C. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

D. Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.

E. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.9 SHEETING, SHORING, AND BRACING

A. Temporary Sheeting - Install temporary sheeting (or sheet piling) with shoring and bracing as required to create a safe working environment and prevent settlement or other damage to adjacent grounds and structures resulting from excavation operations. Shore and brace sheeting in a manner which will not interfere with progress of other work or related contracts (if any) on this project. Check shoring and bracing for settlement, and adjust for settlement. Promptly remove temporary sheeting, shoring, and bracing when no longer required.

B. Permanent Sheeting - Install permanent steel sheet piling or timber sheeting where shown. Cut off top of permanent sheeting 12 inches below finish grade.

3.10 PLACING ENGINEERING FABRIC

A. Place and overlap engineering fabric in accordance with the Manufacturer’s installation instructions, unless otherwise shown.

B. Cover tears and other damaged areas with additional engineering fabric layer extending 3 feet beyond the damage.

C. Do not permit traffic or construction equipment directly on engineering fabric.

D. Backfill immediately over engineering fabric. Backfill in accordance with the fabric manufacturer’s instructions and in a manner to prevent damage to the fabric.

3.11 PLACING FILL AND BACKFILL

A. Surface Preparation of Fill Areas - Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Refer to Section 31 10 00 – Site Preparation for additional information.

1. Remove all asphalt pavement in its entirety from areas requiring the placement of fill.
2. After topsoil is stripped and other improvements specifically indicated to be removed on the Contract Documents are removed, proof roll the site with a ten ton vibratory compactor (minimum six overlapping passes required) or similar equipment. Excavate soft or loose soils identified during rolling and replace with properly compacted select Type 1 granular material as directed by the Owner's Representative or the Architect. Measure additional excavation and backfill as directed by the Owner's Representative or the Architect for payment by the Owner as a Change Order.
3. Plow, strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill materials bond with the existing surface.

B. Excavations - Backfill as promptly as work permits, but not until completion of the following:

1. Acceptance by the Owner's Representative of construction below finish grade including, where applicable, dampproofing, waterproofing, perimeter insulation, and bearing capacity of supporting soil.
2. Inspection, testing, approval and recording locations of underground utilities.
3. Removal of concrete formwork.
4. Removal of temporary sheeting (or sheet piling) and backfilling of voids caused by removals.
5. Cutting off top of permanent sheeting (or sheet piling).
6. Removal of trash and debris.
7. Installation of permanent or temporary bracing on horizontally supported walls.

C. Place backfill and fill materials in layers not more than 8" thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.

1. Place fill and backfill against foundation walls and in confined areas (such as trenches) not easily accessible by larger compaction equipment, in maximum 6" thick (loose depth) layers.
2. For large fill areas, the layer thickness may be modified by the Owner's Representative, at the Contractor's written request, if in the Owner's Representative's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request shall include the type and specifications of compaction equipment intended for use.

D. Prevent wedging action of backfill against structures by placing backfill uniformly around the structure to approximately the same elevation in each layer. Place backfill against walls of structures containing basements or crawl spaces only after the first floor structural members are in place.

E. Under exterior concrete slabs and steps, utilize the following fill materials:

1. Type 1 granular material from subgrade to within 6” of the concrete slab or steps.
2. Select Type 2 crushed stone for the next 6”

F. Under Pavements and Walks - Utilize select Type 2 crushed stone as indicated on the Construction Drawings and in the applicable specification sections in the Project Manual.

G. Landscaped Areas: Place suitable material, when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over 4” in diameter within the top 12” of suitable material.

3.12 ADDITIONAL REQUIREMENTS FOR PLACING FILL TO SUPPORT STRUCTURES

A. Place fill at the perimeter of the structure to be constructed as follows:

1. Strip the area in accordance with the requirements for “Surface Preparation of Fill Areas” included in this Specification Section.
2. Compact the stripped surface to 95% of maximum density.
3. Place fill in horizontal layers not exceeding 8” loose depth and compact layers as specified.

B. Place fill within the perimeter of the structure to be constructed as follows:

1. Strip the area in accordance with the requirements for “Surface Preparation of Fill Areas” included in this Specification Section.
2. Proof roll the stripped surface with at least 5 passes of a vibratory drum compactor having a minimum unsprung drum weight of 7 tons unless specifically indicated otherwise in the Contract Documents. Notify the Owner’s Representative of the proposed date for beginning proof rolling at least 2 working days prior to commencing proof rolling.
3. Excavate unsuitable materials (soft and unstable earth) disclosed by the proof rolling operation and replace with compacted Select Type 1 granular material.
4. Place fill in horizontal layers not exceeding 8” in loose depth and compact layers as specified.

C. Obtain written approval of fill area compaction before excavating for footings.

D. Excavate for footing width plus 1 foot on each side.

E. Excavate 1 foot below footing elevations where bottom of footings are 2 feet or less above or 4 feet or less below original ground surface.

1. Compact footing bottom and place a 1 foot bed of select granular material. Compact select granular material in 6” layers.

2. Omit excavation and select granular material below bottom of footings where footing elevations are more than 2 feet above or more than 4 feet below the original ground surface.

3.13 COMPACTION

A. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than 3% drier nor more than 2% wetter than the optimum content as determined by ASTM D 698 (Standard Proctor) or ASTM D 1557 (Modified Proctor).

1. Structures (entire area within 10 feet outside perimeter) - Compact subgrade and each layer of backfill or fill material to 95%.
2. Concrete Slabs and Steps - Compact subgrade and each layer of backfill or fill material to 95%.
3. Landscaped Areas - Compact the top 2'-0" to a maximum of 85% and compact all subgrade areas beneath the upper 2'-0" to 95%.
4. Natural Turf Athletic Fields - Compact the top 2'-0" to a maximum of 85% and compact all subgrade areas beneath the upper 2'-0" to 95%.
5. Synthetic Turf Playfields - Compact subgrade and each layer of backfill or fill material to 95%.
6. Pavements and Walks - Compact subgrade and each layer of backfill or fill material to 95%.
7. Pipe Bedding - Compact subgrade and each layer of backfill or fill material to 95%.

B. Compaction Equipment:

1. Provide compaction equipment of suitable size and number and in satisfactory working condition to complete construction on schedule.
2. Use sheepsfoot rollers, pneumatic tired rollers, vibrating tampers, or other compaction equipment capable of obtaining required density throughout the entire layer being compacted.

C. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.

D. Moisture Control:

1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
2. Remove and replace or scarify and air dry soil that is too wet to permit compaction to the specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content

is reduced to a value which will permit compaction to the percentage of maximum density specified.

E. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. If compaction cannot be achieved, the material/layer shall be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

3.14 ROUGH GRADING

A. Interior Grading - Trim unexcavated spaces within the building to levels indicated.

1. Subgrade for Interior Slabs: Compact as specified to receive fill material. Finish subgrade surface within 1” above or below level specified for fill required.

B. Exterior Grading - Trim and grade area within the grading limits of the Contract Documents and excavations outside the limits, required by this Contract, to a level of 6” below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide a smooth uniform transition to adjacent areas.

1. Grade areas outside building lines for each structure to drain away from structures and to prevent ponding of water. Finish surfaces free from irregular surface changes and large stones.
2. Landscaped Areas: Provide uniform subgrade surface within 1” of required level to receive topsoil thickness specified. Compact fill as specified to within 2” of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top 4” of the subgrade has become compacted above 85% before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of 4” immediately prior to placing topsoil.

3.15 SUBGRADE SURFACE FOR WALKS AND PAVEMENT

A. Shape and grade subgrade surface as follows:

1. Walks - Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than a ½” above or below the required subgrade surface elevation.
2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½” above or below the required subgrade surface elevation.

B. Grade Control - During construction, maintain lines and grades, including crown and cross-slope of subbase course.

C. Thoroughly compact subgrade surface for walks and pavement by mechanical rolling and tamping, or with vibratory equipment as approved to the density specified.

D. Shoulders - Place shoulders along edges of filled subgrades to prevent lateral movement. Construct shoulders of specified fill material, placed in such quantity to compact to thickness of each subgrade course layer.

3.16 FINISH GRADING

A. Uniformly grade rough graded areas within the grading limits to finish grade elevations indicated.

B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.

C. Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.

D. Finish surfaces free from irregular surface changes, and as follows:

1. Grassed Areas - Finish areas to receive topsoil to within 1” above or below the required subgrade surface elevations.
2. Walks - Place and compact base material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface not more than a ½” above or below the required subbase elevation.
3. Pavements - Place and compact base material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than ½” above or below the required subbase elevation.
4. Building Slabs - Grade base material smooth and even, free of voids, compacted as specified, and to required subbase elevation. Finish final grades within a tolerance of a ¼” when tested with a 10 foot straightedge.
5. Surfaces To Receive Vapor Barrier - Provide smooth surfaces graded, tamped and/or rolled, entirely free of obstructions or protruding objects.

E. Spread topsoil directly upon prepared subgrade surface to a depth measuring a minimum of 6” after natural settlement of the topsoil has occurred in areas to be seeded or to receive sod unless specifically indicated otherwise within the Contract Documents. Place to greater depth when necessary to adjust grades to required elevations.

1. Only approved existing topsoil within the grading limits may be used. Provide additional topsoil from outside sources as required.

F. Finish topsoil surface free of depressions which will trap water, free of stones over ½” in any dimension, and free of debris.

3.17 SUBGRADE AND BASE PREPARATION FOR SYNTHETIC GRASS SURFACING

A. Subgrade Preparation

1. Establish a single benchmark prior to excavation and maintain by a licensed surveyor of record during the entire subgrade preparation and dynamic base installation construction process.
2. Remove all topsoil, organic, deleterious or non-compactable materials. Excavate playfield area to the depth indicated on the Contract Documents.
3. Grade playfield area to minimum 0.5% or more slope from longitudinal center of the field towards the sidelines.
4. Compact the soil bed in a minimum of two directions to attain minimum 95% standard proctor compaction rate unless specifically noted otherwise within the Contract Documents.
5. Laser grade subgrade to tolerances of not more than ¼" in 10' from required elevation to allow for even drainage flow.
6. Excavate perimeter drainage collector trenches to the elevation and profile as indicated on the Contract Documents. All loose debris shall be removed from the trenches prior to pipe installation. Trenches shall be backfilled with specified drainage fill material compacted by hand tamping or similar mechanical means to a minimum 95% of standard proctor maximum density.
7. Install engineering fabric to cover subgrade as detailed on the Drawings. Place fabric in accordance with the "Placing Engineering Fabric" paragraph above.

B. Composite Drain Installation

1. Prior to composite drain installation, ensure subgrade surface is uniform, free of rocks, depression, voids and irregularities.
2. Refer to Section 32 18 13 for composite drain specifications.

C. Stone Base Installation

1. Provide and install a minimum 4" layer or as indicated on the Drawings of specified uniformly mixed stone base without damaging the composite drain system and engineering fabric or forming depressions in the subgrade below.
2. If required compacted stone base exceeds 6" in depth, construct base in two or more layers or lifts of approximate equal thickness. Each layer shall be compacted in minimum two directions to attain required compaction rate.
3. Laser grade stone base at 0.5% from the center longitudinal axis of the playfield towards the sidelines or as specified on the Contract Documents. Ensure elevations of the stone base do not vary from the specified grade by more than ¼" in ten feet in any direction.
4. Place specified finishing stone layer no more than 2" thick and laser grade at 0.5% from the center longitudinal axis of the playfield towards the sidelines or as specified on the Contract Documents. Compact finishing stone in minimum two directions to attain required compaction rate. Ensure that elevations of the stone base do not vary from the specified grade by more than ¼" in ten feet in any direction over the entire playfield area.
5. Mark areas that deviate from the required elevations with spray paint. Correct grade with additional finishing stone rolled tight to comply with required compaction densities.
6. Surface of synthetic turf stone base shall be maintained so as to be well drained at all times, standing water is not permitted.

D. Testing and Survey Verification of Dynamic Base

1. Provide gradation testing for all stone base layers prior to installation. Submit test results to the Architect and the Synthetic Turf Installer for joint approval of the product.
2. Independently confirm compliance with specified tolerances, planarity and elevation of the playfield subgrade and base elevations to be verified by a licensed surveyor and compaction, gradation and permeability verified by a geotechnical engineer.
3. Permeability: The Contractor shall verify permeability of aggregate using DIN 8035 Part 7 (preferred method), ASTM 2434 (constant head), or ASTM D3385 (double ring) testing methods. Take a minimum of one sample per 5000 square feet unless otherwise directed by the Architect.
4. Topographical Survey: A professional land surveyor shall prepare a topographic survey with shots on a ten-foot square grid, a minimum of 72 hours prior to the start of the synthetic turf surfacing installation. The survey shall be submitted to the Owner's Representative and the Architect for evaluation for acceptable planarity and tolerance.

    a. In the event that the synthetic turf base as constructed does not meet the specified requirements, make all necessary repairs within 24 hours to avoid delay in installation of the synthetic grass surfacing.
    b. Coordinate with synthetic grass surfacing installer to ensure synthetic grass installers equipment can run smoothly upon installed granular base without sinking or in any other way disturbing the subbase and base layers.
    c. When directed by the Owner's Representative or the Architect, upon the request of the Synthetic Grass Surfacing Installer, the Contractor shall provide a porosity report prior to the installation of the synthetic grass surfacing.

3.18 MAINTENANCE AND RESTORATION

A. Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

C. Topsoil and seed damaged lawn areas inside and outside the indicated grading limits. Water as required until lawn areas are accepted by the Owner's Representative.

3.19 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Remove from the work site and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

B. If acceptable to the Owner's Representative, transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on the Project Site designated by the Owner's Representative, and dispose of such materials as directed.

C. Transport excess topsoil to areas on the Project Site designated by the Owner's Representative. Smooth grade deposited topsoil.

3.20 FIELD QUALITY CONTROL

A. Tests - The Owner may provide soil testing and inspection services during earthwork operations. The Owner reserves the right to test and approve all subgrades and fill layers before construction proceeds.

B. Compaction Testing: Provide the Owner's Representative adequate notice for all phases of filling and backfilling operations. Compaction testing will be performed by the Owner's Testing Agency to ascertain the compacted density of the fill and backfill materials. Compaction testing will be performed on certain layers of the fill and backfill as determined by the Owner's Representative and the Testing Agency. If a compacted layer fails to meet the specified percentage of maximum density, the layer shall be recompacted and retested. No additional material may be placed over a compacted layer until the specified density is achieved.

C. Tests of subgrades and fill layers may, at the Owner's option, include:

1. Observation of proof rolling procedures.
2. Observation and or inspection of unsuitable soil material.
3. Footing subgrades, for each strata of soil for which footings will be placed, at least one plate bearing test and field density test may be conducted if the subgrade is non-cohesive, or unconfined compression test may be conducted if the subgrade is cohesive, to verify design bearing capacities shown on the Drawings. Subsequent verification and approval of each footing subgrade may be based on visual comparison of each subgrade with tested strata when acceptable to the Architect.
4. Paved areas and building subgrade areas, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made. In addition, in each compacted fill layer, at least one field density test of subgrade for every 2000 square feet of paved area or building slab, but not less than three tests may be made.
5. Foundation wall backfill, field density tests at locations and elevations as directed may be made, with at least one test made for every 50 feet of wall.
6. Fill under footings, in each compacted fill layer; one compaction test for every 30 LF of wall may be taken. One compaction test may be made under each individual footing.
7. Fill under natural turf playfields, at least one field density test of subgrade for every 2000 square feet of playfield area, but not less than three tests may be made. In addition, in each compacted fill layer, at least one field density test of subgrade for every 2000 square feet of overlaying playfield, but not less than three tests may be made.

D. If in the opinion of the Architect and based on reports of the testing service, completed subgrades or fills are below the specified density, provide additional compaction and testing at no additional expense to the Owner.

3.21 PROTECTION

A. Protect graded areas from traffic and erosion and keep them free of trash and debris.

B. Repair and re-establish grades and seeding in settled and rutted areas to specified tolerances.

END OF SECTION 312001

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dewatering system.
2. Surface water control system.
3. System operation and maintenance.
4. Water disposal.

B. Related Requirements:

1. Available Project Information: Subsurface investigation report, indicating boring logs, soil profiles, ground water levels.

2. Contractor to coordinate and gain approval from the with City of Yonkers Plumbing Inspector for discharge locations for dewatering operations during demolition operations.

1.2 DEFINITIONS

A. Dewatering:

1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations.
2. Disposing of removed water.

B. Surface Water Control: The removal of surface water within open excavations.

1.3 COORDINATION

A. Coordinate Work of this Section to permit following construction operations to be completed on dry and stable substrate:

1. Excavation for structures as specified in Section 31 20 00 – Earth Moving.

1.4 SEQUENCING

A. Sequence Work of this Section to obtain required permits before start of dewatering operations. Contractor to procure approval of the City of Yonkers Plumbing Inspector for pump discharge locations as part of the demolition permit.

1.5 SUBMITTALS

A. Product Data:

1. Submit sizes, capacities, priming method, and motor characteristics for dewatering pumps.
2. Submit pumping equipment for control of surface water within excavation.

B. Shop Drawings:

1. Indicate dewatering system layout, well depths, well screen lengths, dewatering pump locations, pipe sizes and capacities, grades, filter sand gradations, surface water control devices, valves, and water disposal method and location.
2. Indicate primary power system location and capacity.
3. Include detailed description of dewatering and monitoring system installation procedures and maintenance of equipment.
4. Include description of emergency procedures to follow when problems arise.

1.6 QUALITY ASSURANCE

A. Comply with the City of Yonkers for following:

1. Water discharge and disposal from pumping operations.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Furnish dewatering and surface water control systems to permit Work to be completed on dry and stable subgrade.

B. Install sump pit to dewater and relieve hydrostatic pressure within the work area.

C. Standby Equipment:

1. Store at Site and ready for immediate use upon failure of dewatering equipment.

2.2 PERFORMANCE AND DESIGN CRITERIA

A. Design:

1. Lower water table within areas of excavation to permit Work to be completed on dry and stable subgrade.
2. Relieve hydrostatic pressures in confined water bearing strata below excavation to eliminate risk of uplift or other instability of excavation.
3. Prevent damage to adjacent properties, buildings, structures, utilities, and other facilities from construction operations.

4. Maintain stability of sides and bottoms of excavations.
5. Surface Water Control System: Collect and remove surface water and seepage entering excavation.

2.3 DEWATERING EQUIPMENT

A. Furnish dewatering equipment to appropriately dewater the work area during demolition if required due to site conditions in accordance with the project plans and requirements of the City of Yonkers.

2.4 ACCESSORIES

A. Valves and Fittings: Furnish valves and fittings as required connect the pump to the discharge location.

B. Filtering materials to ensure that only water is pumped from the site to the discharge locations, in accordance with the City of Yonkers requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Utility Service Locator:
   1. Request that underground utilities be located and marked within and immediately surrounding the site.
   2. City of Yonkers to determine the acceptability of the existing building sewer connections to the combined storm sewer for dewatering discharge location.

3.2 PREPARATION

A. Protect existing adjacent buildings, structures, and improvements from damage that may be caused by dewatering operations.

3.3 DEWATERING SYSTEM

A. Install dewatering system according with project plans and requirements of the City of Yonkers demolition permit.

B. Locate system components to allow continuous dewatering operations without interfering with installation of permanent Work and existing public rights-of-way, sidewalks, and adjacent buildings, structures, and improvements.

C. Pumps:

   1. Install according to manufacturer instructions.

2. Connect pumps to discharge location.
3. Install valves to permit pump isolation.

3.4 SURFACE WATER CONTROL SYSTEM

A. Provide ditches, berms, and other devices to divert and drain surface water from excavation area, as specified in Section 31 25 00 - Erosion and Sedimentation Control.

B. Divert surface water and seepage water within excavation areas into sumps and pump water into locations designated by the City of Yonkers.

C. Control and remove unanticipated water seepage into excavation.

3.5 SYSTEM OPERATION AND MAINTENANCE

A. Operate dewatering system as needed to dewater excavations during the demolition project.

B. Dewatering operations to continue on an as needed basis until the time of the building construction commences, as necessary and in accordance with the requirements of the City of Yonkers.

C. Monitoring:

1. Conduct daily observation of dewatering system and monitoring system.
2. Make required repairs and perform scheduled maintenance.

D. Start emergency generators at least twice each week to check operating condition.

E. System Failure:

1. If dewatering system cannot control water within excavation, notify Engineer and stop excavation Work.

F. Modify dewatering and surface water control systems if operation causes or threatens to cause damage to new construction, existing Site improvements, adjacent property, or adjacent water wells.

G. Correct unanticipated pressure conditions affecting dewatering system performance.

H. Do not discontinue dewatering operations without approval of Engineer.

3.6 WATER DISPOSAL

A. City of Yonkers to determine ultimate discharge location of the dewatering line as part of the demolition permit.

3.7 SYSTEM REMOVAL

A. Remove dewatering and surface water control systems after dewatering operations are discontinued.

B. Repair damage caused by dewatering and surface water control systems or resulting from failure of systems to protect property.

3.8 PROTECTION

A. Protect sump pits and dewatering equipment from damage by construction operations.

END OF SECTION 312319

SECTION 312333 – TRENCHING AND BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes excavation and backfill as required for pipe installation or other construction in the trench, and removal and disposal of water, in accordance with the applicable provisions of Section 31 20 00 Earth Moving and Section 31 50 00 Excavation Support and Protection unless modified herein.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 EXCAVATION

A. The trench excavation shall be located as shown on the Drawings or as specified. Under ordinary conditions, excavation shall be by open cut from the ground surface. Where the depth of trench and soil conditions permit, tunneling may be required beneath cross walks, curbs, gutters, pavements, trees, driveways, railroad tracks and other surface structures. No additional compensation will be allowed for such tunneling over the price bid for open cut excavation of equivalent depths below the ground surface unless such tunnel excavation is specifically provided for in the Bidding Documents.

B. Trenches shall be excavated to maintain the depths as shown on the Drawings or as specified for the type of pipe to be installed.

C. The alignment and depth shall be determined and maintained by the use of a string line installed on batter boards above the trench, a double string line installed along side of the trench or a laser beam system.

D. The minimum width of trench excavation shall be 12 inches on each side of the pipe hub.

E. Trenches shall not be opened for more than 300 feet in advance of pipe installation nor left unfilled for more than 100 feet in the rear of the installed pipe when work is in progress without the consent of the Engineer. Open trenches shall be protected and barricaded as required. No trench shall be left open over night unless an adequate road plan is provided.

F. Bridging across open trenches shall be constructed and maintained where required. Provide shop drawing of bridging or road plate system designed and stamped by NYS Licensed Professional Engineer.

3.2 SUBGRADE PREPARATION FOR PIPE

A. Where pipe is to be laid on undisturbed bottom of excavated trench, mechanical excavation shall not extend lower than the finished subgrade elevation at any point.

B. Where pipe is to be laid on special granular material the excavation below subgrade shall be to the depth specified or directed. The excavation below subgrade shall be refilled with special granular material as specified or directed, shall be deposited in layers not to exceed 6 inches and shall be thoroughly compacted prior to the preparation of pipe subgrade.

C. The subgrade shall be prepared by shaping with hand tools to the contour of the pipe barrel to allow for uniform and continuous bearing and support on solid undisturbed ground or embedment for the entire length of the pipe.

D. Pipe subgrade preparation shall be performed immediately prior to installing the pipe in the trench. Where bell holes are required they shall be made after the subgrade preparation is complete and shall be only of sufficient length to prevent any part of the bell from becoming in contact with the trench bottom and allowing space for joint assembly.

3.3 STORAGE OF MATERIALS

A. Traffic shall be maintained at all times in accordance with the applicable Highway Permits, Division 01 General Requirements, and Drawings.

B. Where conditions do not permit storage of materials adjacent to the trench, the material excavated from a length as may be required, shall be removed by the Contractor, at his cost and expense, as soon as excavated. The material subsequently excavated shall be used to refill the trench where the pipe had been built, provided it be of suitable character. The excess material shall be removed to locations selected and obtained by the Contractor.

1. The Contractor shall, at his cost and expense, bring back adequate amounts of satisfactory

excavated materials as may be required to properly refill the trenches.

C. If directed by the Engineer, the Contractor shall refill trenches with satisfactory soil materials or other suitable materials and excess excavated materials shall be disposed of offsite by the contractor.

3.4 REMOVAL OF WATER AND DRAINAGE

A. The Contractor shall at all times provide and maintain proper and satisfactory means and devices for the removal of all water entering the trench, and shall remove all such water as fast as it may collect, in such manner as shall not interfere with the prosecution of the work.

B. The removal of water shall be in accordance Section 01 50 00 Temporary Facilities and Controls.

3.5 PIPE EMBEDMENT

A. All pipe shall be protected from lateral displacement and possible damage resulting from superimposed backfill loads, impact or unbalanced loading during backfilling operations by being adequately embedded in suitable pipe embedment material. To ensure adequate lateral and vertical stability of the installed pipe during pipe jointing and embedment operations, a sufficient amount of the pipe embedment material to hold the pipe in rigid alignment shall be uniformly deposited and thoroughly compacted on each side, and back of the bell, of each pipe as laid.

B. Concrete cradle and encasement of the class specified shall be installed where and as shown on the Contract Drawings or ordered by the Engineer. Before any concrete is placed, the pipe shall be securely blocked and braced to prevent movement or flotation. The concrete cradle or encasement shall extend the full width of the trench as excavated unless otherwise authorized by the Engineer. Where concrete is to be placed in a sheeted trench it shall be poured directly against sheeting to be left in place or against a bond-breaker if the sheeting is to be removed.

C. Embedment materials placed above the centerline of the pipe or above the concrete cradle to a depth of 12 inches above the top of the pipe barrel shall be deposited in such manner as to not damage the pipe. Compaction shall be as required for the type of embedment being installed.

3.6 BACKFILL ABOVE EMBEDMENT

A. The remaining portion of the pipe trench above the embedment shall be refilled with suitable materials compacted as specified.

1. The trench shall be refilled in horizontal layers not more than 8 inches in thickness, and

compacted per Section 31 20 00 Earth Moving.

2. Hand tamping shall be required around buried utility lines or other subsurface features that could be damaged by mechanical compaction equipment.

B. Backfilling of trenches beneath, across or adjacent to drainage ditches and water courses shall be done in such a manner that water will not accumulate in unfilled or partially filled trenches and the backfill shall be protected from surface erosion by adequate means.

1. Where trenches cross waterways, the backfill surface exposed on the bottom and slopes thereof

shall be protected by means of stone or concrete rip-rap or pavement.

C. All settlement of the backfill shall be refilled and compacted as it occurs.

D. Temporary pavement shall be placed as required by the Highway Work Permits and all Laws and Regulations.

END OF SECTION 312333

SECTION 312500 - EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. New York State Department of Environmental Conservation SPDES General Permit for Stormwater Discharges from Construction Activity Permit No. GP-0-20-001.

1.2 SUMMARY

A. This section includes furnishing, installing, maintaining, and removing temporary erosion and sediment control measures as shown on the contract documents or as ordered by the Engineer throughout the life of the contract to control soil erosion, sediment and water pollution through the use of temporary swales, check dams, bales, sediment traps, and silt fences.

B. Related Sections include other Division 2 Sections.

1.3 REFERENCES

A. Materials installation, maintenance, inspection and removal shall be in accordance with the *New York Standards and Specifications for Erosion and Sediment Control*.

1.4 SUBMITTALS

A. Submittals shall be submitted in accordance with the provisions set forth in the General Specifications.

B. Submittal shall contain source and supplier of material showing its compliance with specifications and associated standards.

1. Samples of any kind shall be submitted upon Engineer’s request.

C. The Contractor shall submit schedules for the accomplishment of temporary sediment control work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products shall be as specified on the contract drawings and as stated in *New York Standards and Specifications for Erosion and Sediment Control*.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In the event of conflict between these specification requirements and pollution control laws, rules or regulations by other federal, state or local government agencies, the more restrictive rules and regulations shall apply.

B. Temporary erosion and sediment control measures shall be inspected by the Contractor and maintained during the life of the project, and such maintenance and inspection shall continue until permanent stabilization measures are in place and the temporary control measures are ordered to be removed by the Engineer, and the disturbed area returned to its intended stabilized condition.

C. The Engineer has the authority to limit the surface area of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary erosion and sediment control measures to minimize damage to adjacent property.

D. The Contractor shall submit schedules for the accomplishment of temporary and permanent erosion and sediment control work to the Engineer for acceptance. All work done under this section shall be included as part of the construction schedule submitted by the Contractor.

E. Maintenance shall be performed as directed by the Engineer. All sediment deposits shall be considered unsuitable material and properly disposed of.

F. The Contractor shall immediately repair or replace defective or damaged portions of the erosion and sediment control facilities.

G. Erosion and sediment control measures shall be installed where necessary and shall remain in place until the area is permanently stabilized or the Engineer directs that it be removed. Upon removal, the Contractor shall remove and dispose of any sediment accumulations and restore the area as directed by the Engineer. The removed facilities and materials shall become the property of the Contractor and be removed from the site.

END OF SECTION 312500

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and Division 01 General Requirements, Section 31 20 00 Earth Moving, apply to this Section.

B. This Section applies to all asphalt paving.

1.2 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.

B. Scheduling of Asphalt Paving:

1. The contractor shall have substantially completed site work in the vicinity of paving and obtain the Engineer's approval prior to placement of the binder course of asphalt.
2. The contractor shall have substantially completed construction and obtain the Engineer's approval prior to placement of the top course of asphalt.

1.3 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of the standard specifications of the state or authorities having jurisdiction.

1. Standard Specification: New York State Department of Transportation.
2. Measurement and payment provisions and safety program submittals included in NYSDOT Standard Specifications do not apply to this Section.

1.4 SUBMITTALS

A. Product Data: For each product specified. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: For each job mix proposed for the Work.

C. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

D. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

A. Provide in accordance with Division 01 General Requirements.

B. Installer Qualifications: Engage and experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

1. Firm shall be a registered with and approved paving mix manufacturer with authorities having jurisdiction or the DOT of the state in which Project is located.

D. Regulatory Requirements: Conform to applicable standards of authorities having jurisdiction for asphalt paving work on public property.

E. Asphalt-Paving Publication: Comply with AI's , "The Asphalt Handbook," except where more stringent requirements are indicated.

F. Pre-installation Conference: Conduct Pre-installation conference at the Site per Division 01 General Requirements. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

1. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
2. Review condition of substrate and preparatory work performed by other trades.
3. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
4. Review and finalize construction schedule for paving and related work. Verify availability of materials, paving Installer's personnel, and equipment required to execute the Work without delays.
5. Review inspection and testing requirements, governing regulations, and proposed installation procedures.
6. Review forcasted weather conditions and procedures for coping with unfavorable conditions.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

.

1. Asphalt Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.
2. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound; angular crushed stone, crushed gravel, or properly cured, crushed blast-furnace slag; complying with ASTM D 692.

C. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof, complying with ASTM D 1073

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D 242.

2.2 ASPHALT MATERIALS

A. Asphalt Cement: ASTM D 3381 for viscosity-graded material

B. Undersealing Asphalt: ASTM D 3141, pumping consistency.

C. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

2.4 MIXES

A. Hot-Mix Asphalt: Provide dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction**;** designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: As indicated.
3. Surface Course: As indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify Engineer in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been corrected.

3.2 PATCHING AND REPAIRS

A. Patching: Saw cut perimeter of patch and excavate existing pavement section to sound base. Recompact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.
1. Tack coat faces of excavation and allow to cure before paving.
2. Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Leveling Course: Install and compact leveling course consisting of dense-graded, hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

C. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm). Refill with asphalt joint-filling material to restore watertight condition. Remove excess filler that has accumulated near cracks or joints.

D. Tack Coat: Apply uniformly to surfaces of existing pavement of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m) of surface.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.
3. Spread mix at minimum temperature of 250 deg F (121 deg C).
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in AI's, "The Asphalt Handbook".
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

2. Use at minimum a 10-ton roller.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch (6 mm).
2. Surface Course: 1/8 inch (3 mm).
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing agency to perform field quality-control testing.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. Revise methods of verifying field compaction if using the Superpave mix design system. Consult state or local DOT for methods that have been successfully used.

E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

SECTION 321217 - ASPHALT PAVING FOR PLAY AREA WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Aggregate base for asphalt paving
B. Asphalt paving installation over aggregate base
C. Joining new asphalt pavement to adjacent construction
D. Field quality control

1.2 RELATED SECTIONS

A. Section 312001 – Earth Moving for Play Area Work
B. Section 321314 – Concrete Paving for Play Area Work
C. Section 321820 – Play Court Surfacing and Accessories

1.3 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.

C. Job Mix Formulas: Submit job mix formulas for asphalt paving indicating compliance with the requirements of each asphalt type specified including the name and location of the supplier.

D. Quality Control Submittals

1. Certificates: Submit one copy of all permits obtained from local regulatory agencies and the New York State Department of Transportation.
2. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements specified below in the "Quality Assurance" section of this specification.
3. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable requirements specified in the "Quality Assurance" section of this specification.

E. Closeout Procedures: Comply with the requirements of Section 017700.

1.4 QUALITY ASSURANCE

A. Asphalt Producer Qualifications: Use only materials furnished by bulk asphalt producer regularly engaged in the production of hot-mix, hot laid asphalt.

B. Regulatory Requirements

1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, which ever is more stringent for methods and materials in work areas subject to applicable agency's review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
2. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

1.5 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply tack coats when ambient temperature is below 50 degrees F., and when the temperature has not been above 35 degrees for 12 hours immediately prior to the application. Do not apply a tack coat when an asphalt base is wet or contains an excess of moisture.
2. Do not construct asphalt surface courses when the atmospheric temperature is below 40 degrees F., and when base material is not dry. Asphalt may only be placed when air temperatures are a minimum of 40 degrees F. and rising.

B. Field Measurements: Establish and maintain required lines and elevations for grade control.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate Base: Comply with the New York State Department of Transportation Standard Specification, Section 304, Paragraph 304-2, as modified in Section 312001 – Earth Moving for Play Area Work.

1. Base Course: Type 2 crushed stone as modified in Section 31200 – Earth Moving for Play Area Work unless specifically noted otherwise on the Contract Documents.

B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification. Section 400 for the materials indicated.

1. Binder Course: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt – Type 3 Binder.

Sieve		Percent Passing	
Sieve Size	Sieve Size (mm)	General Limits	Job Limit Tol. %
1 ½"	37.5	100	-
1"	25.0	95 – 100	-
½"	12.5	70 – 90	+/-6
¼"	6.3	48 – 74	+/-7
No. 6 Sieve	3.2	32 – 62	+/-7
No. 20 Sieve	.850	15 – 39	+/-7
No. 40 Sieve	.425	8 – 27	+/-7
No. 80 Sieve	.180	4 – 16	+/-4
No. 200 Sieve	.075	2 – 8	+/-2

a. The PGB content shall be 4.5 – 6.5%, +/-0.4%.
b. The mixing and placement temp. range shall be 120 – 165 degrees C.

2. Shim Course: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt – Type 5 Shim.

Sieve		Percent Passing	
Sieve Size	Sieve Size (mm)	General Limits	Job Limit Tol. %
¼"	6.3	100	-
No. 6 Sieve	3.2	80 – 100	+/-6
No. 20 Sieve	.850	32 – 72	+/-7
No. 40 Sieve	.425	18 - 52	+/-7
No. 80 Sieve	.180	7 – 26	+/-4
No. 200 Sieve	.075	2 – 12	+/-2

a. The PGB content shall be 7.0 – 9.5%, +/-0.4%.
b. The mixing and placement temp. range shall be 120 – 165 degrees C.

3. Topcourse: Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Section 401 and 403 for Asphalt – Type 7 Topcourse.

Sieve		Percent Passing	
Sieve Size	Sieve Size (mm)	General Limits	Job Limit Tol. %
½"	12.5	100	-
¼"	6.3	90 – 100	-
No. 6 Sieve	3.2	45 – 70	+/-6
No. 20 Sieve	.850	15 – 40	+/-7
No. 40 Sieve	.425	8 – 27	+/-7
No. 80 Sieve	.180	4 – 16	+/-4
No. 200 Sieve	.075	2 – 6	+/-2

a. The PGB content shall be 5.7 – 8.0%.
b. The mixing and placement temperature range shall be 120 – 165 degrees C.

C. Coatings: Comply with the New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.

1. Tack Coat: Emulsified asphalt, slow setting type, New York State Department of Transportation designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
2. Asphalt Cement Filler: New York State Department of Transportation Designation 702-05.

2.2 EQUIPMENT

A. Paving Equipment: Spreading, self propelled asphalt paving machines capable of maintaining the line, grade and minimum surface thickness specified. Spreader boxes may be used in areas where specifically approved by the Project Designer.

B. Compacting Equipment: Self-propelled tandem roller with a minimum 10-ton weight. Handheld vibrator compactor may be used in areas not accessible to rollers when specifically approved by the Architect.

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the Installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the Installer.

3.2 PREPARATION

A. Final Preparation of Subgrades: Upon completion of preparation of subgrades as specified in Section 312001, thoroughly scarify the entire area to be paved and compact by rolling to smooth, hard, even surface. Finish to required grades with allowance for pavement courses above.

3.3 INSTALLATION

A. Aggregate Base: Comply with the requirements of the New York State Department of Transportation Standard Specification, Section 304-3, for aggregate gradations specified, unless otherwise indicated.

1. Base Course: Completely fill voids with grits and roll with a 10-ton roller, eliminating movement of the material ahead of the roller. After rolling, verify grading with a minimum ten-foot-long straight edge. Satisfactorily eliminate any depression over ¼" deep. Obtain approval of base prior to installing asphalt courses above

    a. Play Area Duty Pavement Thickness: Minimum 12" thickness (two 6" layers) unless otherwise noted.

B. Asphalt Paving: Pave finished surface free from depressions that may collect water. The Contractor shall remove any depressions at their own expense over 1/8" deep when tested with a six foot straight edge without evidence of patching.

1. Play Area Duty Paving: Pave over aggregate base in two courses, 1½" compacted depth topcourse over 2½" compacted depth binder course. Comply with the New York State Department of Transportation Standard Specification, paragraph 401-3 and paragraph 403-3 for asphalt types specified.

C. Joining New Asphalt Pavement to Adjacent Construction

1. Carefully construct joints between old and new pavements, or between successive days work to ensure continuous bond between adjoining paving. Construct joints with the same texture, density and smoothness as adjacent sections of asphalt courses. Clean sand, dirt and other deleterious material from contact surfaces and apply tack coat.
2. Offset traverse joints a minimum of 24" between succeeding courses. Cut back pavement to the edge of previously placed courses to expose an even, vertical surface for the full course thickness.
3. Offset longitudinal joints a minimum of 6" between succeeding courses. When edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back all unsatisfactory sections to expose an even, vertical surface for the full course thickness.
4. In horizontal joints between the binder and the topcourse, clean all contact surfaces and spray a tack coat prior to the installation of the topcourse if the binder has been in place for longer than seven days or if the pavement is determined to be excessively dirty by the Project Designer.
5. Seal joints with the application of asphalt cement filler, a minimum of 2" to each side of the joint.

3.4 FIELD QUALITY CONTROL

A. Flood Tests: Perform a flood test in the presence of the Owner's Representative or the Architect utilizing a water tank truck. If a depression ponding water more than 1/8" in depth is found, provide corrective measures to provide proper drainage.

END OF SECTION 321217

THIS PAGE HAS INTENTIONALLY BEEN LEFT BLANK

SECTION 321314 - CONCRETE PAVING FOR PLAY AREA WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preparation for concrete paving
B. Placement of fabric reinforcement
C. Placement of concrete
D. Placement of joints and sealants
E. Placement of detectable warning surface
F. Finishing and curing

1.2 RELATED SECTIONS

A. Section 312001 – Earth Moving for Play Area Work
B. Section 321217 – Asphalt Paving for Play Area Work

1.3 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data

1. Concrete Mix Design: Submit proposed concrete design mix together with the name and location of the batching plant.
2. Portland Cement: Brand and manufacturer’s name.
3. Air Entraining Admixture: Brand and manufacturer’s name.
4. Water Reducing or High Range Water Reducing Admixture: Brand and manufacturer’s name.
5. Curing and Anti-Spalling Compound: Manufacturer’s specifications and application instructions.
6. Welded Wire Mesh and Reinforcing Bars and Dowels: Manufacturer’s name.
7. Joint Fillers and Sealants: Catalog sheets, specifications and installation instructions for each product specified.
8. ADA Detectable Warning Surface: Manufacturer’s specifications, product data, test reports, method of installation, and maintenance instructions.

C. Closeout Procedures: Comply with the requirements of Section 017700.

1.4 QUALITY ASSURANCE

A. At location directed by the Architect, construct concrete flatwork sample panel approximately 5’ wide by 15’ long.

B. Concrete batching plants shall be currently approved as concrete suppliers by the New York State Department of Transportation.

C. Regulatory Requirements

1. Conform to the requirements of local regulatory agencies, or if applicable, the New York State Department of Transportation, which ever is more stringent for methods and materials in work areas subject to applicable agency's review and approval. Provide materials complying with referenced New York State Department of Transportation Standard Specifications where indicated.
2. Obtain written permission from applicable agencies prior to the start of construction.

1.5 PROJECT CONDITIONS

A. Maintain access for vehicular and pedestrian traffic as required for other construction activity. Provide barricades, warning signals, warning lights, and similar items as required.

B. Environmental Conditions

1. Humidity and Moisture: Do not install the work under this specification section under conditions that are detrimental to the installation, curing and performance of the specified materials.
2. Temperature: Unless otherwise approved or recommended in writing by the sealant manufacturer, do not install sealants below 40 degrees F. or above 85 degrees F.

C. Protection: Protect all newly poured concrete surfaces from damage. Protect all surfaces adjacent to sealants with non-staining, removable tape or other approved covering to prevent soiling or staining.

PART 2 PRODUCTS

2.1 MATERIALS

A. Cast-In-Place Concrete: Normal weight, air entrained concrete with a minimum compressive strength of 4,500 psi at the end of 28 days.

1. Design Air Content: ASTM C 260, and on the New York State Department of Transportation's current "Approved List"; 6% by volume +/- 1.5%.
2. Cement: ASTM C 150 Type I or II portland cement. Minimum 6.5 bags or 611 pounds per cubic yard.
3. Water: Potable.
4. Slump: Between 2 and 4 inches except when a water reducing admixture is used, the maximum slump shall be 6 inches. When a high range water reducing admixture is used, the maximum slump shall be 8 inches.
5. Water Reducing Admixture: ASTM C 494, Type A and on the current New York State Department of Transportation's current "Approved List".
6. High Range Water Reducing Admixture: ASTM C 494, Type F and on the current New York State Department of Transportation's current "Approved List".

B. Chemical Curing and Anti-Spalling Compound: Water based, acrylic polymer, Type 1, Class A (non-yellowing) compound complying with the requirements of ASTM C 1315.

1. For convenience, details and specifications have been based on the following manufacturers and their products:

a. Vocimp 25 by W.R. Meadows, Inc., Hampshire IL.
b. Super Diamond Clear VOX, Euclide Chemical Co., Inc., Cleveland, OH.
c. Cure and Seal 25% J22UV by Dayton Superior, Dayton, OH.

C. Reinforcement

1. Welded Wire Mesh: Flat sheets of welded, plain, cold drawn steel wire fabric complying with ASTM A 185. Rolled wire will not be acceptable for installation as part of the project.
2. Reinforcing Bars and Dowels: Deformed steel bars, ASTM A 615, Grade 60.

D. Joint Sealants

1. For horizontal joints, two part self leveling polyurethane sealant for traffic bearing construction.

a. For convenience, details and specifications have been based on the following manufacturers and their products:

(1) Vulkem 255 by Mameco International, Inc., Beachwood, OH.
(2) Urexpan NR-200 by Pecora Corp, Harleysville, PA.
(3) Chem-Calk 550 by Bostik Inc., Middleton MA.
(4) Sealtight Porthane Sealant by W.R. Meadows, Elgin, IL.
(5) Sonolastic SL-2 Joint Sealant Slope Grade by Sonneborn Building Products Inc., Minneapolis, MN.

2. For vertical joints, two part non-sag polyurethane sealant.

a. For convenience, details and specifications have been based on the following manufacturers and their products:

(1) Vulkem 227 by Mameco International, Inc., Beachwood, OH.
(2) Dynatrol II by Pecora Corp, Harleysville, PA.
(3) Chem-Calk 500 by Bostik Inc., Middleton MA.

E. Joint Fillers

1. Closed Cell Polyurethane Joint Filler: Resilient, compressible, semi-rigid, closed cell isometric polymer foam material, minimum ½" thick similar to Ceramar Joint Filler as manufactured by W.R. Meadows, Inc., Elgin IL.

a. Fiber board or cork joint filler material is not acceptable for use in concrete expansion joint work.

2.2 EQUIPMENT

A. Forms: Steel of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Coat forms with non-staining, clear, paraffin based form oil that will not discolor or otherwise stain concrete surfaces.

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which pavement is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the Work.

1. When the Installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the Installer.

3.2 PREPARATION

A. Surface Preparation: Remove all loose material from the compacted sub-base surface prior to placing concrete.

B. Forms: Set forms for 5" thick sidewalks unless specifically noted otherwise true to line and grade and anchor rigidly into position.

C. Space expansion joints equally at not more than 30'-0" on center.

D. Place joint filler at expansion joints and where new concrete abuts existing concrete paving and fixed structures and appurtenances. Protect the top edge of the joint filler during concrete placement with a temporary cap and remove after concrete has been placed. Fill expansion joint with joint sealant after the concrete has been cured complying with the sealant manufacturers installation instructions.

3.3 PLACEMENT OF FABRIC REINFORCEMENT

A. Prior to placement of woven wire mesh, clean thoroughly of mill and rust scale and of coatings that could destroy or reduce bond.

B. Install fabric reinforcement midway between the top and bottom of the concrete slab. Prior to placing concrete, place fabric reinforcement midway between the

top and bottom of the slab and secure against displacement with the use of chair carriers or other approved materials.

A. Lap edges and ends of adjoining sheets of fabric reinforcement at least half the mesh width. Offset end laps in adjacent sheets to prevent continuous joints at ends. Interrupt reinforcement at expansion joints, stopping 2” from edges.

3.4 PLACING CONCRETE

A. Moisten the concrete subgrade as required to provide a uniform dampened condition at the time that concrete is placed.

B. Do not place concrete around manholes or other structures until these items are brought to the required grade and alignment.

C. Consolidate concrete by spading, rodding, forking or using an approved vibrator eliminating all air pockets, stone pockets and honeycombing. Work and float concrete surface so as to produce a uniform texture.

D. Locate construction joints (if any) at expansion joint locations.

E. Deposit and spread concrete in a continuous operation between control joints.

3.5 PLACING DETECTABLE WARNING SURFACE

A. Detectable warning surfaces shall be installed 6 inches behind the edge of the curb.

B. Domes shall be aligned on a square grid in the predominant direction of travel to permit wheels to roll between the domes.

C. Install pre-cast units in accordance with the manufacturer’s instructions.

D. The curb, detectable warning surface, and sidewalk shall be flush with the elevation of the road surface.

3.6 FINISHING AND CURING

A. After striking off and consolidating poured concrete, smooth the surface by screeding and floating. Adjust floating to compact the surface and produce a uniform texture.

B. After floating, test the surface for trueness utilizing a 10’ steel straight edge. Distribute concrete as required to remove surface irregularities and refloat repaired areas to provide a continuous smooth finish.

C. Provide broom finish for walk surfaces.

D. Finish edges of walk and expansion joints with a ½” radius edging tool. Space tool joints equally between expansion joints at approximately 5’-0” on center, unless specifically detailed otherwise on the construction documents.

E. Apply curing and anti-spalling compound in accordance with the manufacturer's printed instructions.

F. Saw control joints one inch deep after the concrete has set. Space control joints equally between expansion joints at approximately 5'-0" on center, unless specifically detailed otherwise on the construction documents.

3.7 FIELD QUALITY CONTROL

A. Testing by Owner of Concrete Sidewalks

1. Contractor Requirements

a. Provide access to concrete construction and concrete supplier's facilities for representatives of the testing agency employed by the Owner to perform concrete testing and facility inspections as described below.
b. Notify the Owner's Representative at least 48 hours in advance of each concrete placement to allow notification of the Owner's Testing Agency.

2. Concrete Testing During Construction by the Owner's Testing Agency

a. Sampling Method: ASTM C 172 modified for slump to comply with ASTM C94.
b. Slump Testing (ASTM C143): One test for each concrete load at the point of discharge. One test for each set of compressive strength test specimens, and one test from the middle of each load.
c. Air Content Testing (ASTM C231, Pressure Method): One of each set of compressive strength test specimens; air content checked on every fourth load of "ready-mix" concrete delivered.
d. Compressive Strength Testing

(1) Specimen Preparation: In compliance with ASTM C31 requirements to prepare one set of standard cylinders (minimum six each) for each compressive strength test.
(2) Specimen Testing: In compliance with ASTM C39 requirements for testing of one set of specimens for each 100 cubic yards (or fraction thereof) of each type of concrete placed in each day as follows

(a) Two specimens at seven days after concrete completion.
(b) Three specimens at 28 days after concrete placement.
(c) One specimen retained for later testing, if required.

e. Reporting: Reports containing the following information shall be provided in writing by the Owner's Testing Agency to the Architect and the Prime Contractor the same day the tests are accomplished.

(1) Project identification name and number.
(2) Name of prime contractor, concrete supplier and testing agency.
(3) Number (or other designation) of truck delivering the concrete.

(4) Concrete type and class, date of placement, and location of concrete batch within the project.
(5) Design compressive strength at 28 days.
(6) Concrete mix proportions and materials.
(7) Compressive breaking strength and type of break for both 7 day test and 28 day test.

f. Concrete Temperature: Test hourly when air temperature is 40 degrees F. or lower, or when the air temperature is 80 degrees F. or above, and each time compression testing specimens are prepared.
g. Inspection of Supplier Facilities: The Owner's Testing Agency may inspect the concrete supplier's batch plant and review batching procedures as deemed necessary by the Owner, including inspecting the aggregate washing facility, concrete heating system, and concrete transportation equipment.
h. Inspection of Reinforcing Steel: The Owner's Testing Agency may inspect placement of reinforcing steel. Do not begin concrete placement on any pour unless the Owner's Representative and the Architect have been notified at least one day preceding the pour to allow reasonable time for inspection of the reinforcing steel.

3.8 ADJUSTING AND CLEANING

A. Repairs and Protection of Concrete Sidewalks

1. Repair or replace broken or defective concrete as directed by the Architect.
2. Protect concrete from damage until acceptance of concrete sidewalk construction. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain walks as clean as possible by removing surface stains as they occur.
3. Sweep concrete walks and wash them free of stains, discoloration, dirt, and other foreign materials just prior to final acceptance.

B. Patching Existing Construction: Repair or patch adjacent existing concrete or other surfaces damaged from concrete sidewalk construction.

END OF SECTION 321314

SECTION 321813 – SYNTHETIC GRASS SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Provide labor, materials, services, and equipment necessary to furnish and install synthetic surfacing work as indicated and as specified herein, includes, but not limited to:

1. Preparation of stone base and underdrain system.
2. Surfacing of athletic field.
3. Installation of lines, yard markers, and logos.

1.2 RELATED SECTIONS

A. Section 116833 – Athletic Field Equipment
B. Section 312001 – Earth Moving for Play Area Work
C. Section 321314 – Concrete Paving for Play Area Work
D. Section 323113 – Chain Link Fences and Gates

1.3 SUBMITALS

A. Submit the following within 72 hours of bid opening, as requested:

1. Most recent installation/reference list for all projects of similar scope to this project completed in the last three years.
2. Required 3rd party insurance policy, demonstrating that all of the requirements outlined in Section 1.4 Quality Assurance are met. Actual policy must be submitted.
3. One (1) 12" x 12" sample of proposed synthetic turf carpet and one (1) 12" x 12" boxed turf sample including infill representative of finished synthetic turf system. Also submit product data and testing documents demonstrating that the proposed system meets or exceeds all specified requirements.

B. Submit the following prior to the ordering of materials:

1. Material Certificates and Samples: Provide certificate for each material from material producer that will be used for this project. Each material certificate must be stamped and checked as approved by the Field Builder before submittal to the Architect.
2. Provide to the Architect materials samples of the following: Two (2) 12" x 12" samples of synthetic turf carpet and color yarn samples, (2) 1-lb. bagged samples infill material.

3. Prior to order of materials, the Field Builder shall submit a sample warranty, seam layout plan, striping plan and any details of construction that deviate from the plans and specifications.

C. Quality Control Submittals

1. Test Reports

a. Submit certified copies of independent, third party laboratory test reports for synthetic turf playfield system components as follows:

(1) Pile height, face width and total fabric weight per ASTM D418 or D5848.
(2) Primary and secondary backing weights per ASTM D418 or D5848.
(3) Tuft bind per ASTM D1335.
(4) Grab tear strength per ASTM D1682 or D5034.
(5) Pill burn test per ASTM D2859.

b. Submit necessary test data from the Installer to the Owner indicating that the finished field meets the required shock attenuation as per ASTM F355.

2. Existing Installation Listing: Provide a list, including project name, owner's representative name and telephone number for a minimum of ten fields of 65,000 SF or more installed in the United States during the past two years with the same turf manufacturer, including the same infill products, fiber, and fiber manufacturer proposed for this project.

3. Dynamic Base Stone Acceptance: Prior to beginning installation of synthetic turf surfacing, arrange for a representative of the synthetic turf manufacturer and installer shall inspect the dynamic base stone. The manufacturer and the installer must certify the acceptance of the dynamic base stone for the purpose of obtaining the Manufacturer's warranty for the finished synthetic playing surface.

4. Lead Components – As part of the approval process of the submitted product, the synthetic turf playfield system supplier must certify in writing that no lead or lead chromate components are utilized in the manufacturing of the turf.

1.4 REFERENCES

A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern. The latest edition of the following standards as referenced herein shall be applicable.

1. National Federation of State High School Associations (NFHS), "Rules Book" for the following sports:

a. Futsal Soccer

B. Factory Mutual Research Corporation: P7825 Approval Guide – Factory Mutual Research Corporation, current edition

C. American Society for Testing and Materials Standards

1. ASTM C88 – “Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate”
2. ASTM D418 – “Standard Method of Testing Pile Yarn Floor Covering Construction”
3. ASTM D422 – “Standard Test Method for Particle Size Analysis of Soils”
4. ASTM D698 – “Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbs/cubic foot)”
5. ASTM D1338 – “Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings”
6. ASTM D1557 – “Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/cubic foot)”
7. ASTM D1577 – “Standard Test Method for Linear Density of Textile Fibers”
8. ASTM D1682 – “Standard Method of Tests for Breaking Load and Elongation of Textile Fabrics”
9. ASTM D2256 – “Standard Test Method for Tensile Properties of Yarns by the Single Strand Method”
10. ASTM D2859 – “Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials”
11. ASTM D2922 – “Standard Test Methods for Density of Soil and Soil Aggregate in Place by Nuclear Methods”
12. ASTM D3385 – “Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer”
13. ASTM D5034 – “Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)”
14. ASTM D5848 – “Standard Test Method for Mass per Unit Area of Pile Yarn Floor Coverings”
15. ASTM F355 – “Standard Test Method for Shock Absorbing Properties of Playing Surface Systems and Materials”
16. ASTM F355-10 – “Procedure A: Testing Services Including Test Number TSI 1202”
17. ASTM F1015 – “Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces”
18. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity”
19. ASTM F1551 – “Standard Test Method for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Materials”
20. ASTM F1936 – “Standard Test Method for Shock Absorbing Properties of North American Football Field Playing Systems as Measured in the Field”

1.5 QUALITY ASSURANCE

A. Provide a qualified installation foreman to coordinate and review the component parts of the artificial turf system. Submit a resume of experience for Architect's approval prior to starting work.

B. Granulated Infilled Artificial Turf:

1. Factory-trained technicians skilled in the installation of athletic-caliber infilled synthetic turf systems will undertake the placement of the turf. Special brushing equipment and techniques will be used in the installation.
2. The designated installation crew shall have installed a minimum of ten high quality, stadium grade granulated infilled synthetic turf systems of 65,000 square feet or greater in the past three years.
3. A notarized letter from the Field Builder that the installation crew and foreman are factory certified must be submitted prior to the start of turf installation.

C. Provide a colored striping plan detailing lines, numbers and letters. Coordinate with Owner or Owner's Representative and Architect to get final approval of all designated colors, dimensions and logo/lettering designs.

D. The Field Builder shall meet the following criteria:

1. Manufacturer/Field Builder's Experience:
   a. The Turf Manufacturer and the Field Builder must be experienced in the manufacturing and installation of this type of artificial turf system and provide project references of the synthetic grass system being installed at 100 similar exterior sites in the United States over the last 5 years, a minimum of 65,000 square feet each.
   b. The Field Builder must have actively been in business, under its current name and ownership for at least the past ten years; and must have a minimum of 25 athletic fields still in use in the United States for a minimum of the past 10 years.
   c. The Field Builder must provide competent workmen skilled in this type of artificial turf installation. The designated Supervisory personnel on the project must be certified, in writing, by the Field Builder as competent in the installation of this material, including gluing or sewing seams and proper installation of the infill mixture. The Field Builder shall have a qualified job foreman on site to certify the installation and warranty compliance

E. Warranty - The Prime Contractor and/or Manufacturer shall provide a total twelve (12) year warranty to the Owner that includes the following in writing in the warranty document:

1. The turf warranty shall be from a single source and shall provide full coverage for all defects in all materials and workmanship of the synthetic turf for its intended usability and playability for the specified warranty period from the Date of Final Completion and acceptance of the turf field.

The turf manufacturer must verify that their on-site representative has inspected the installation and that the work conforms to the Manufacturer's requirements.

2. In addition to the required Turf Contractor's/Manufacturer's single source warranty, an additional prepaid insurance policy supported from a third party, A.M. Best, A-rated or better domestic insurance carrier shall be provided for the initial eight-year warranty period. The insurance policy should comply with the following:

    a. Be written specifically naming the field or fields being constructed as part of this project requiring payment of a claim be made directly to the Owner of said field. Evidence of such coverage must be submitted and approved.
    b. The value of the insured warranty shall be $1,000,000 for each insured warranty with a $5,000,000 annual aggregate.
    c. Only true 3rd party warranties are acceptable. Letters of credit submitted as a policy will be rejected as an acceptable substitution to true 3rd party insurance policy.
    d. Three copies of the actual 3rd party insurance policy must be provided with the warranty as part of the initial synthetic turf approval submittal package.
    e. The 3rd party warranty shall be limited to the initial eight (8) year portion of the synthetic turf system warranty. The additional four (4) year warranty required for the aggregate ten (12) year warranty after the initial eight (8) year duration is completed shall then convert to a standard single source company warranty provided by the Manufacturer covering, but not solely limited to addressing issues such as seam repair, maintenance of specified G-max standards, U.V degradation of fibers, general fiber failure, etc.

3. The turf warranty shall include general wear and damage caused from ultra-violet degradation. Vandalism and Acts of God beyond the control of the synthetic turf manufacturer shall be excluded.
4. The turf warranty shall specifically list what components and properties are covered by the warranty. The list shall include, but not be limited to any and all defects or failures relating to construction of the synthetic turf system, drainage through the synthetic turf system, synthetic turf seam rupture, synthetic turf yarn ultra-violet stability, excessive wear and tensile strength.
5. The turf warranty shall cover defects in the workmanship of installation and further warrants that the installation was done in accordance with both the Manufacturer's recommendations and any written directives of the Manufacturer's on-site representative.
6. The turf warranty shall include all necessary materials, labor, transportation costs, etc., to complete repairs or replacements and dispose of removed materials. The warranty shall guarantee the availability of the same or better replacement materials for the synthetic turf system for the warranty period.
7. The turf warranty shall be non-prorated and shall not place limits on the amount of field's usage.
8. The turf warranty cannot include any form of deductible amount.

9. The turf warranty shall clearly define the conditions under which the Manufacturer considers the warranty to be void.
10. The turf warranty shall define the typical time frame within which repairs will be initiated by the synthetic turf contractor, once notice has been received requesting repairs.
11. The turf warranty shall guarantee that adhesive bonded or sewed seams of all system components remain permanent, tight, secure and hazard free for the entire athletic field playing surface. In addition, all inlaid markings shall remain in place throughout the duration of the warranty period.
12. The turf warranty shall guarantee the installed synthetic turf system's drainage capability shall allow water flow through the entire turf and infill of not less than 10 inches per hour.
13. The warranty shall guarantee the G-max ratings at the completion of construction and for the duration of the warranty as described in this specification.

F. MAINTENANCE

1. The synthetic turf contractor shall provide training for the Owner regarding the recommended maintenance program for the synthetic turf field. The training shall include a detailed review of the turf maintenance manual required to be provided by the synthetic turf manufacturer.

2. The synthetic turf contractor shall provide training for the Owner's facility maintenance staff in the use of the field groomer and all other equipment to be utilized for maintenance of the synthetic turf field.

3. Extra Materials: Upon final completion, provide the following materials directly to the Owner in the minimum quantities specified:

   a. Turf fabric – 100 SF of each color used in playing field areas and logos, excluding the field line colors, with at least one piece of each color being 5' wide by 10' long.
   b. 4" Wide Colored Fabric – Minimum 100 LF of each color specified for inlaid line striping.
   c. 2000 pounds ground rubber in weatherproof bags.
   d. Minimum one 15' x 10' piece of each type of green turf used on the Project.

PART 2 - PRODUCTS

2.1 SYNTHETIC GRASS SYSTEM

A. Synthetic Grass System Description – Futsal Soccer (Legion NXT 2.0)

1. Face Yarn Type: Polyethylene slit and monofilament fibers.

2. Pile Weight: 50 oz/sy minimum. It is acceptable to increase pile weight to meet minimum total product weight required for this turf system.
3. Primary Backing: Minimum 8 oz/sy, double layered polypropylene fabric treated with U.V. inhibitors. It is acceptable to increase primary backing weight to meet minimum total product weight required for this turf system.
4. Secondary Backing: Minimum 20 oz/sy urethane permanently locking fiber tufts in place. It is acceptable to increase secondary backing weight to meet minimum total product weight required for this turf system.
5. Total Product Weight: Total weight of system pile, primary backing and secondary backing to be minimum 78 oz/sy.
6. Yarn Linear Density: Minimum 15,800 denier total.
7. Yarn Thickness: Minimum 100 microns for slit film fiber and 375 microns for monofilament fiber.
8. Pile Height (Finished): Minimum 2.00” nominal finish height.
9. Color: Green (as approved by Owner).
10. Construction: Broadloom tufted
11. Tufting Gauge: Maximum ½”.
12. Turf Permeability: >25” per hour.
13. Tuft Bind Without infill: Minimum 10 lbs.
14. Grab Tear (Width): Minimum 200 lbs.
15. Grab tear (Length): Minimum 200 lbs.
16. Flamability (Pill Burn): Pass.
17. Infill Composition: Minimum 3 lbs each /sf ambient or cryogenic SBR crumb rubber particles and rounded or sub-angular, uniformly sized silica sand.
18. Infill Depth: Minimum 1.75” deep at installation.
19. Finished Roll Width: The carpet shall be delivered in 15-foot-wide rolls with 4” lines tufted into each roll where appropriate.
20. Markings: Provide all necessary game markings shall conform to NFHS standards for baseball, soccer and unified lacrosse.
21. Warranty: Total of 12 years (8-year standard warranty plus 4-year supplemental warranty) from date of Final Completion.
22. Manufacturer of synthetic turf athletic surfacing complying with these specifications include Shaw Sports Turf (Telephone #877-260-7888.

B. Resilient Infill: A resilient infill system, consisting of minimum weights per square foot of rubber or a rubber and sand mixture as specified above engineered to provide the look, feel, footing and shock absorption of a natural grass field in ideal conditions.

1. Sand Particulate. The sand provided as a component of the infill mixture shall be rounded or sub-angular silica sand to minimize abrasion to the athlete and synthetic grass fibers.

2. Rubber Particulate. The rubber provided as a component of the infill mixture shall be ground SBR crumb rubber mixture.

2.2 VERTICAL DRAINAGE BASE MATERIALS

C. Excavation: Existing natural grass field shall be excavated to the depth established by the Architect and as shown on the excavation plan. The sub grade shall be shaped to achieve a .5% (one half of one percent) slope from the center of the field to each sideline in order to mirror the grade of the finished synthetic turf surface. The sub grade shall also be compacted and proof rolled to a minimum of a 95% compaction rate.

D. Geotextile Filter Fabric: Non-woven polypropylene geotextile fabric shall be chemically and biologically inert and shall be Mirafi 140N or approved equal.

E. Drainage Pipe: A network of perforated HDPE highway grade drainage pipe (1" x 12" flat panel pipe with geotextile wrap) shall be installed under a 10" layer of free draining base aggregate. The drainage pipe will be installed in a herringbone pattern every 15 feet on center and shall be connected to perimeter collector lines as shown on drawings. End connectors shall be fabricated for use with 4” drain pipe. Material to be similar to ADS Advantage pipe or approved equivalent.

F. Stone Base Courses: The following gradation of stone is a typical and recommended specification. The synthetic turf base installer is required to focus on achieving the planarity, porosity and compaction requirements to provide a sound crushed stone base for synthetic turf installation above. The final base course materials shall be approved by the synthetic turf manufacturer and contractor prior to installation at the project site.

1. The free-draining base aggregate base layer shall consist of a consistent depth of open graded material. Base drainage aggregate used must achieve a 95% minimum overall compaction rate. Material shall conform to the AASHTO #57 limestone classification.

2. The choker material shall be AASHTO #8. 200 sieve must not exceed 7% passing.

2.3 SEAMS

A. Adhesives for bonding tufted synthetic turf shall be two-component fast-set urethane adhesive obtained from a single manufacturer and be equivalent to Ultrabond Turf PU 2K as manufactured by Mapei Corporation, Deerfield Beach, FL (800) 992-6273, or one-part moisture-cured polyurethane obtained from a single manufacturer and be equivalent to 34-G as manufactured by Synthetic Surfaces, Inc., Scotch Plains, NJ (908) 233-6803, or approved equal as designated by the Field Builder.

1. Seaming Tape: Tape for securing seams in the tufted synthetic turf and inlaid lines shall be high quality tape made with a minimum roll width of 12 inches.

B. Sewn seams: If seams are to be sewn, they must be sewn with high quality cord/thread as recommended by Field Builder.

C. Line Painting: No line painting will be allowed. All markings are to be factory tufted or inlaid at the project site.

D. Panel/Roll Seams: Provide 99% sewn installation; gluing of rolls shall not be acceptable. Minimal gluing will be permitted to repair problem areas, corner completions, and to cut in any logos or inlaid lines as required. All panel seams shall be sewn using double bagger stitches and polyester thread. Make all seams flat, tight, and permanent with separation or fraying.

PART 3 - EXECUTION

3.1 SYNTHETIC FIELD SURFACE

A. The synthetic turf base contractor shall strictly adhere to the installation procedures outlined under this section. Any variance from these requirements must be accepted in writing, by the Field Builder's on-site representative, and submitted to the Architect/Owner, verifying that the changes do not in any way affect the warranty.

B. Sub-Grade: The sub grade shall be shaped to mirror the slope of the finished synthetic turf surface as indicated on the grading plan. The sub grade shall also be compacted and proof rolled to a minimum of a 95% compaction rate. Areas which cannot achieve the minimum compaction shall be over-excavated and structural fill shall be installed and re-compacted to the minimum compaction required.

C. Install geotextile fabric over the prepared sub-grade. Provide a 36" minimum overlap at all seams. Fabric shall first be installed in the drainage trenches prior to installation of perimeter collector lines. After backfilling of all trenches is complete, the entire field shall be covered with fabric prior to the base aggregate application.

D. Trenching, Drainage Pipe Installation and Backfilling: All piping shall be as specified and connected by Field Builder's couplers, plugs etc.

1. The base grade shall be shaped to mirror the finished grade and approved by the Architect and/or Owner's Representative. The base contractor shall begin layout and trenching for the drainage network as indicated on the drainage plan and all details that apply. Collector lines shall be installed before lateral lines and shall begin with the deepest elevations. Collector lines shall be connected to discharge outlet at the onset of operations. Trenching progress shall work upward in elevation to allow for immediate discharge of water from the entire field in the event of a rainfall.

2. No trenches, with or without pipe, shall be permitted, to remain unfilled overnight and/or while crews are not progressively working on site.

3. All perimeter trenches must be dug in accordance with the field drainage plan details.

4. After all collector and lateral lines have been installed, the base contractor shall repair any sub grade undulations prior to installing geotextile fabric.

E. Concrete Header Curb and Pressure Treated Wood Turf Nailer: The synthetic turf perimeter fastening structure shall be installed before the drainage aggregate.

1. The concrete header curb shall be installed in accordance with the Drawings and/or Shop Drawings and these Specifications. The foundation of the concrete header curb shall be a compacted free draining aggregate. Future water entering the foundation shall have a free draining path directly to the perimeter collector pipe.

2. Install a pressure treated wood 2" x 4" nailer. Pressure treated wood nailer shall be set at a distance equal to the synthetic turf finished pile height below top of the curb by means of a Tapcon or ramset every 12 inches. This shall be the responsibility of the base contractor.

F. Base Drainage Aggregate: The installation of the base drainage aggregate shall only begin after the drainage pipe installation has been inspected and approved by Owner's Representative. Installation of the free draining base aggregate shall follow procedures that protect the base grade soils and drainage pipe. The drainage pipe network and its existing elevations shall not be disrupted through ground pressures from trucks, dozers or by any other means.

1. The base grade subsoil shall be dry before undertaking the placement of base aggregate.

2. Delivery trucks shall enter the field only from the designated entrance point. Base course stone shall be dumped closest to the entrance first and continuously worked towards the furthest point of the field. Extreme care must be taken not to disturb sub grade or drainage network.

3. Track-type dozers shall push out the stone from behind the pile onto and toward the field center. Dozers shall only traffic the aggregate they are spreading.

4. Bulldozer blades shall be equipped with a laser-guided hydraulic system. Care shall be taken not to disturb or contact the base grade soils with the dozer blades or tracks. All equipment trafficking over the drainage aggregate shall ensure there is a minimum depth of 9" of aggregate between the geotextile fabric and the dozer track ground contact position.

5. When the aggregate spreading is completed, the surface shall be further-firmed by a 5-ton roller. Static vibration shall not be part of this process.

6. The stone shall be left firm, but not over-compacted as to protect the porosity and drainage capabilities of the aggregate profile.

7. After the drainage stone has been uniformly spread throughout the surface, the surface shall receive a final laser finished grade. This process shall be accomplished using a turf-type tractor, or lightweight grader, equipped with high flotation tires and a hydraulically controlled laser blade.

8. The free-draining base course must be installed to a depth as recommended by the Field Manufacturer and shall be independently tested for an overall compaction rate of 95% proctor.

G. Choker Levels: The base drainage stone final elevations shall mirror the proposed choker layer final grade material. Care shall be taken not to allow the coarser aggregate to surface into the profile or finished grade of the choker layer.

1. The choker layer shall be applied using high flotation grading equipment. The choker material shall be evenly spread throughout the proposed field surface to the final pre-pad or pre-turf elevations.

2. After the choker material has been uniformly spread throughout the surface by the described method, the surface shall receive a final laser finish grade. This process shall be accomplished using a turf-type tractor, or lightweight grader, equipped with high flotation tires and a hydraulically controlled laser blade.

3. Care shall be taken throughout the installation not to force the choker material into the porosity of the base aggregate below.

4. Final choke layer must be installed to design grades with a finished surface tolerance deviating no more than ¼ inch over 10 feet in all directions. The base contractor must provide a topographical survey with a minimum of 200 shots demonstrating finished grade meets all written requirements.

5. Final layer of stone must be installed at a depth as recommended by the field manufacturer. Finished aggregate base must be proof-rolled by means of 2- to 5-ton roller. The finished aggregate base must achieve an overall compaction rate of 95% proctor in accordance with ASTM D1557. It shall also be flush with top of pressure treated wood nailer.

6. The synthetic turf base contractor is required to string line the entire field every five feet to identify high and low spots. And identified high and low spots must be eliminated prior to installation of the synthetic turf. The base layer topography must be accepted by the synthetic turf manufacturer and installer prior to installing the synthetic turf grass system above.

H. Base Acceptance: The Architect and/or Owner's Representative must jointly approve the base before the turf installation can begin.

I. Synthetic Turf and Infill Materials

1. After a final inspection of the base by the field builder and the Owner's Representative, the synthetic turf installation shall begin. The first roll shall begin with the longest perpendicular cross-field distance. No head seams shall be permitted in the inbound playing surface.

2. The rolls of turf shall be rolled out a minimum of four hours prior to starting seaming procedures and allowed to relax/expand.

    a. All visible wrinkles shall be stretched out before seaming.
    b. Seams shall be flat, tight and permanent with no separation or fraying.
    c. Synthetic turf yarn fabric that is trapped or glued between seams shall be freed from the seams by hand or other approved method to an upright position prior to the commencement of brushing and topdressing procedures.
    d. All synthetic turf seams shall be assembled as follows: The full width rolls shall be laid out across the field. Utilizing standard state of the art adhering or sewing procedures, each roll shall be attached to the next.
    e. When all of the rolls of the playing surface have been installed, the sideline areas shall be installed perpendicular to the playing field. The yard lines, game markings, sidelines, etc. of all applicable sports shall be tufted into carpet by the manufacturer wherever possible.

3. After all seaming is completed and inlaid lines, logos and lettering have been installed; the infill materials shall be spread evenly, using a drop spreader or top dresser.

    a. Granulated infill material shall be applied in a uniform rate of multiple applications until the specified infill depth is achieved.
    b. Infill material shall be brushed between infill applications with a motorized rotary broom and pull-type groomer brush simultaneously.
    c. A minimum infill rate of material per square foot as indicated in Part 2 of this specification is required.

J. Tufted and Inlaid Lines

1. Layout and descriptions of tufted and inlaid lines shall conform to the NFHS standards and approved by the Owner prior to installation.

2. Inlaid lines and field markings shall be cut in using seaming methods recommended by the field builder.

K. Synthetic Turf Perimeter Attachment:

1. After final trimming of the turf, the turf shall be screwed or nailed to the pressure treated wood nailer system as per the field builder’s recommendations.

3.2 FIELD LAYOUT

A. Field layout shall be as shown on the record drawings. Typically, the final approved striping and seaming plan used to manufacture and install the field is acceptable. Any Owner-approved changes that take place during the installation must be marked in red and resubmitted.

3.3 CLOSEOUT

A. The Field Builder must verify that a qualified representative has inspected the installation and that the finished field surface conforms to the field builder's requirements.

B. The field builder must submit three (3) copies of its standard maintenance manual to the owner.

C. Field builder must train Owner's designated field personnel in proper grooming and care procedures. This includes training field personnel how to properly use grooming equipment as well as make minor repairs.

3.4 CLEAN UP

A. Field builder shall provide the labor, supplies and equipment as necessary for final cleaning of surface and installed items.

B. All usable remnants of new material shall be neatly rolled up and turned over to the Owner at a place and area designated by the Owner.

C. During the contract and at intervals as directed by the Architect and as synthetic turf installation is completed, clear the site of all extraneous materials, rubbish, or debris and leave the site in a clean, safe, well-draining, neat condition.

D. Surface, recesses, enclosures, etc. shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

3.5 G-MAX AND INFILL DEPTH TESTING

A. Verification of installed infill depth and G-max testing to be performed by an independent testing firm retained and paid for by the Contractor. The testing firm must be approved by the Owner prior to Contractor authorizing any testing work.

1. Infill Depth: Measurement of infill to verify depth shall be taken at a minimum of ten locations throughout each installed playfield area. The amount of installed infill shall in all cases meet the minimum specified depth with an allowable tolerance of plus/minus 1/8”.

2. G-Max: Testing shall be performed to verify that shock attenuation properties of the field meet the requirements indicated in this specification. Upon construction completion of the synthetic turf playfield, in place G-Max testing of the synthetic turf system shall be performed in accordance with ASTM F355 and ASTM F1936. G-Max ratings shall fall between 100 and 135 at all test locations with the average of all G-Max readings not exceeding 125.

B. The Owner shall periodically test the playfield area for G-Max properties throughout the entire warranty period of the synthetic turf playfield at their own expense. If test results show that G-Max readings exceed 165 at any location, the synthetic turf contractor shall take all steps necessary to correct the condition. The synthetic turf contractor shall provide the Owner with adequate information to describe the corrective measures to be utilized and shall follow-up in writing confirming that the work provided was successful.

END OF SECTION 321813

SECTION 321820 - PLAY COURT SURFACING AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Preparation of asphalt surface to receive color coating.
B. Installation of acrylic color and texture coating systems.
C. Linestriping of pickleball, and basketball, and painted play surface areas.
D. Installation of pickleball, and basketball court accessories.

1.2 RELATED SECTIONS

A. Section 116813 – Playground Equipment
B. Section 312000 – Earth Moving for Play Area Work
C. Section 321216 – Asphalt Paving for Play Area Work

1.3 SYSTEM DESCRIPTION

A. Design Requirements - Acrylic color and texture system, linestriping and associated accessories complying with the standards specified and approved by the United States Tennis Association and American Sports Builders Association.

1.4 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures.

B. Product Data - Submit manufacturer’s name, specifications and installation instructions for each item specified.

C. Samples - Submit a minimum of three sets of samples of finish and materials as required for color selection by Owner, Owner’s Representative and Architect.

D. Quality Control Submittals

1. Qualifications Certification - Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the requirements of this specification.
2. Experience Listing - Submit a list of completed projects using the products proposed for this project, including owner’s contact information and telephone number for each project.

E. Closeout Procedures - Comply with requirements of Section 017700.

1.5 QUALITY ASSURANCE

A. General - The systems listed reflect the intent to establish required play court surface function and standard of quality for construction.

B. Qualifications - Play court surfacing installer shall have completed a minimum of 10 multi-purpose play court installations using the proposed materials.

1.6 PROJECT CONDITIONS

A. Field Measurements - Establish and maintain elevations for grade control.

B. Environmental Conditions - Apply various color and texture systems, painted linestriping and associated equipment in accordance with the Manufacturer's recommended weather limitations.

1.7 SEQUENCING AND SCHEDULING

A. Proceed with, and complete play court surfacing and installation of associated accessories as rapidly as portions of the work area become available, working within seasonal limitations for the tasks required.

PART 2 PRODUCTS

2.1 PLAY COURT SURFACING

A. Manufacturer - For convenience, details and specifications have been based on "Action Pave Acrylic Color Coating Products" by Copeland Coating Company, Inc., Nassau, New York (Tel. #1-800-303-4219).

1. Other products that comply with these requirements include "Nova Crylic Sports Surfaces", by Nova Sports USA, Milford, Massachusetts.

B. Materials

1. Leveling Binder Patch - Durable, acrylic emulsion mixed on site to level and fill low areas, composed of one-part binder patch, 2 parts 75 – 100 mesh dry silica sand and 1/3-part portland cement.
2. Resurfacer Coat - Heavy bodied, 100% acrylic emulsion developed specifically for use on open or pitted asphalt surfaces to reduce porosity and provide uniform surface texture prior to applying filler and finish coats above.
3. Filler Coat - Fully pigmented, 100% acrylic emulsion with special reinforcing pigments and pure silica sand providing durable, flexible, uniform and controlled texture.
4. Finish Coat - Fully pigmented, 100% acrylic emulsion with special prime color reinforcing pigments specifically engineered to protect against UV rays.
5. Line Paint - Durable, white, 100% acrylic emulsion paint.

2.2 PICKLEBALL EQUIPMENT AND ACCESSORIES

A. Manufacturer - For convenience, details and specifications have been based on products by Douglas Industries, Eldridge, Iowa (Tel #1-800-553-8907).

1. Pickleball Posts- “PPS-22SQ” Premier Portable Pickleball System, four sets required.
2. Pickleball Net - “PN-30”, four sets required.

B. Pickleball Posts – Portable play system complying with the following requirements:

1. Heavy duty base frame constructed of 11-gauge, 3” square steel and 3½” square 3/16” heavy-wall steel
2. System complete with cast aluminum alloy caps and gear housings.
3. Baked on polyester, black powder coat finish.
4. Chrome plated gear plate and handle.
5. Internally wound, self-locking gear mechanism.
6. Plated steel gears.
7. Case hardened, small gear with 30 to 1 operation.
8. Removable handle.
9. End wheel assembly with heavy-duty non-scuff swivel casters allowing for smooth and easy mobility complete with lift assist handles at each post end to flip the transporter bracket up and out of the way while unit is in play.

C. Pickleball Net - Official size nets complying with the following requirements:

1. Size: 31” high by 21’-9” long.
2. Netting: 3.0 mm, solid core knotted braided polyethylene netting with 285 lb. break strength.
3. Headband: Single ply vinyl coated polyester, 32 oz/SY.
4. Side Pockets: Black vinyl with fiberglass dowels.
5. Center Strap Anchor: Vecro

2.3 BASKETBALL STANDARD

A. Manufacturer - For convenience, details and specifications are based on “Signature Series MVP Outdoor System” by Goalsetter Systems Inc.; Lynnville, Iowa (Tel. #1-800-362-4625).

1. Permanently installed, single post equipment capable to adjust height to between 6 feet and 10’ tall with internal jack complying with the following:

a. Ground Anchor: 6” square by 42” long structural steel tubing with 3/16” wall thickness and hinged ½” X 7¾” X 9½” steel mounting plate on top.
b. Pole: Offset design, 6” square structural steel tubing with 3/16” wall thickness and hinged ½” X 7¾” X 9½” steel mounting plate at the bottom. The pole shall include a visual height indicator located on one side to verify rim height.
c. Height Adjustment System: Internal compression height adjustment system contained inside pole designed to operate in compression rather than tension allowing the unit to infinitely adjust between 6’ and 10’ in height through the use of a removable height adjustment crank handle which extends from the back of the mast approximately 36” from the base.

d. Extension Arms: 1½" X 3" X 11-gauge rectangular steel tubing.
e. Backboard: Regulation, rectangular, 42" X 72" X 3/8" fortified acrylic marked with a regulation border and target area. Support frame shall be 1½" square rectangular steel tubing. Steel rim mounting plate shall be ¼" X 7¼" 10". The backboard shall extend a minimum of 48" from the pole at any height.
f. Rim: Double static rim constructed of high tensile alloy steel protected with baked on powder coat finish and nylon net.
g. Hardware: All fasteners, pivot pins and set collars to be zinc plated with additional ultra-coat for corrosion resistance. All pivot points shall include nylon bushings eliminating steel to steel contact.
h. Finish: Minimum one coat of surface primer and minimum two coats of high gloss acrylic enamel paint.
i. Weight: 585 pounds.
j. Concrete: 3000 lbs. concrete mix for footing installation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions - Examine conditions under which play court surfacing and associated accessories are to be installed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. Installation of the play court surfacing shall not take place if adjacent or concurrent construction activities generate excessive dust, abrasives or other byproducts that are harmful to the play court material.
2. Work shall be delayed if weather and other climatic conditions are detrimental to the proper installation of surfacing materials. The installation temperature shall be 50 degrees F. and rising and installation of tennis court surfacing materials shall be executed only during dry conditions.
3. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.2 SURFACE PREPARATION

A. Prior to the application of the acrylic color and texture system, flood the entire court surface with water and allow to drain. Any depressions holding water more than 1/8" deep shall be patched and leveled in accordance with the recommendations of the color coat wearing surface manufacturer.

B. Install play court post sleeves and accessories in accordance with Manufacturer's recommendations before applying color and texture system.

C. Prior to the application of the first acrylic surfacing coat, inspect the entire play court area to ensure that the surface is sound, smooth and free from loose dirt and oily materials.

3.3 INSTALLATION

A. The acrylic color and texture systems shall be applied to a clean and dry pavement in conformance with the Manufacturer's instructions and recommendations.

B. Acrylic Color and Texture System (Minimum Four Coat Application)

1. Resurfacer Coat - Apply a minimum of one coat of acrylic resurfacer to the entire court area in accordance with the Manufacturer's written instructions. Allow the acrylic resurfacer coat to dry. Inspect the entire area to remove any loose or foreign particles and ridges.
2. Filler Coat - Apply two coats of acrylic color filler fortified with 80 mesh silica. The filler coat must be pigmented by the Manufacturer, use of neutral base coating is not acceptable. If the surface is not uniformly covered with an even texture and free of all porosity, the contractor shall apply a third filler coat. Allow the filler coat to dry in accordance with the Manufacturer's recommendations and then inspect the entire surface to remove any loose or foreign particles and ridges.
3. Finish Coat - Apply minimum of one coat of acrylic color finish producing uniform color over entire court surface when viewed from distance of 25 feet from any edge of the court at mid-day. The finish coat must be pigmented by the Manufacturer, use of neutral base coating is not acceptable.
4. Court Colors - The color of the courts shall be chosen by the Owner from the manufacturer's full range of standard colors.

C. Court Markings - Hand tape and mark the courts with 2" wide, white acrylic line paint. The courts shall be marked in accordance with all applicable standards. Apply the line paint as recommended by the Manufacturer.

D. Equipment and Accessories

1. Install all play equipment and other specified accessories in accordance with the Manufacturer's recommendations.
2. Install all equipment and accessories plumb and level, properly aligned between sections and neatly finished.
3. Upon completion of specified work, leave installation adjusted and in perfect working order. Clean equipment and surrounding construction made dirty as a result of tennis equipment installation. Remove all debris and surplus material.

3.4 ADJUSTING AND CLEANING

A. Repairs and Protection of Play Court Surfacing and Accessories

1. Repair defective court surfacing and accessories as directed by Architect.
2. Protect court surfacing and accessories from damage until work acceptance.

END OF SECTION 321820

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Excavation for fence post bases
B. Concrete anchorage for posts
C. Installation of chain link fences
D. Installation of chain link gates

1.2 RELATED SECTIONS

A. Section 321217 – Asphalt Paving for Play Area Work
B. Section 321314 – Concrete Paving for Play Area Work
C. Section 321813 – Synthetic Grass Surfacing
D. Section 329200 – Turf and Grasses

1.3 REFERENCES

A. Comply with ASTM A 53 for requirements of Schedule 40 piping.

1.4 DEFINITIONS

A. Height of Fence: Distance measured from the top of the concrete footing to the top of the fabric.

1.5 SUBMITTALS

A. Comply with the requirements of Section 01 33 00 – Submittal Procedures and as modified below.

B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.

C. Shop Drawings: Complete detailed drawings for each height and style of fence and gate required. Include separate schedule for each, listing all materials required and technical data such as size, weight and finish to ensure conformance to the specifications.

D. Quality Control Submittals

1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the “Qualifications” requirements specified below in the “Quality Assurance” section of this specification.
2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner’s contact information and telephone number for each project, demonstrating compliance with

applicable “Qualifications” requirements specified in the “Quality Assurance” section of this specification.

E. Closeout Procedures: Comply with the requirements of Section 017700.

1.6 QUALITY ASSURANCE

A. Comply with the standards of the Chain Link Fence Manufacturer’s Institute, including (unless otherwise indicated):

1. Specification for Metallic Coated Steel Chain Link Fence Fabric
2. Industrial Steel Specification for Fence Rails, Posts, Gates and Accessories
3. ASTM F-567 - Standard Practice for Installation of Chain Link Fence for installation unless otherwise indicated on the Contract Documents.

B. Qualifications

1. Provide metal fences and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fasteners. Products shall be provided by a company specializing in commercial quality chain link fencing with at least five years experience.

C. Regulatory Requirements

1. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in “Submittals-Quality Control Submittals” above.

1.7 PROJECT CONDITIONS

A. Field Measurements: Establish and maintain required lines and elevations for grade control.

1.8 SEQUENCING AND SCHEDULING

A. Proceed with and complete chain link fence and gate installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.1 MATERIALS

A. Framework Standards

1. Steel Pipe: Cold rolled steel pipe meeting the requirements of ASTM A-569 with a minimum yield strength of 50,000 psi.
2. Interior Coating: In line applied zinc rich coating with zinc powder loading of a minimum 90% by weight applied after fabrication conforming to ASTM B 6 high grade and Special High-Grade Zinc.

3. Exterior Coatings

    a. Base Coat: Minimum .9 ounces zinc per square foot.
    b. Intermediate Coat: Minimum 15 microgram chromate conversion per square inch.
    c. Top Coat: Minimum 0.3 mil cross link polyurethane acrylic exterior coating.
    d. PVC exterior coating: Fusion bonded polyvinyl chloride similar to Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan. Color to be black unless specifically noted otherwise on the Contract Documents.

4. Size of Pipe: As indicated.
5. Similar to SS-40 Pipe with Flo-Coat by Allied Tube and Conduit Corporation, Harvey, Illinois.

B. Framework and Footings for Fences Up To 6’-0” High

    a. End Posts, Corner Posts and Pull Posts.

        a. Pipe: 2.50” O.D.
        b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
        c. Footing Size: 12” O.D. by 4’-0” deep.

    b. Line Posts

        a. Pipe: 2.00” O.D.
        b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
        c. Footing Size: 12” O.D. by 4’-0” deep.

C. Framework and Footings for Fences 7’-0” To 9’-0” High

    a. End Posts, Corner Posts, Pull Posts and Line Posts (All Posts).

        a. Pipe: 3.00” O.D.
        b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
        c. Footing Size: 12” O.D. by 4’-0” deep.

D. Framework and Footings for Fences 10’-0” To 12’-0” High

    a. End Posts, Corner Posts and Pull Posts.

        a. Pipe: 4.00” O.D.

b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
c. Footing Size: 18" O.D. by 5'-0" deep.

b. Line Posts

a. Pipe: 3.00" O.D.
b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
c. Footing Size: As shown on drawings.

E. Framework and Footings for Fences Over 12'-0" High

a. End Posts, Corner Posts and Pull Posts.

a. Pipe: 4.00" O.D. unless specifically noted otherwise on the Contract Documents.
b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
c. Footing Size: As shown on drawings

b. Line Posts

a. Pipe: 4.00" O.D.
b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
c. Footing Size: As shown on drawings

F. Post Brace: Provide manufacturer's standard adjustable brace at gate posts and at both sides of corner and pull posts, with a horizontal brace located at the mid-height of the fabric. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

G. Top Intermediate and Bottom Rails

1. 1.66" O.D. pipe, weighing 1.84 pounds per linear foot. Install rails in the manufacturer's longest lengths utilizing expansion couplings, approximately 6" long at each joint. Provide means for attaching the top rail securely to each gate post, corner post, pull post and end post.

a. Provide bottom rail for all fences 4'-0", 6'-0", 8'-0" in height and over.
b. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

H. Swing Gate Posts

1. Single leaf of gate up to 6' wide and less than 10' in height: 2.875" O.D. pipe, 5.79 pounds per linear foot.
2. Single leaf of gate 6' to 12' wide or over 10' in height: 4.00" O.D. pipe, 9.11 pounds per linear foot.
3. Single leaf of gate 12' to 18' wide: 6.625" O.D. pipe, 18.97 pounds per linear foot.
4. Single leaf of gate over 18' wide and less than 10' in height: 8.625" O.D. pipe, 24.70 pounds per linear foot.

I. Swing Gate Framework

1. Up to 6'-0" high and leaf width of 8'-0" or less: 1.660" O.D. pipe, 2.27 pounds per linear foot.
2. 6'-0" to 12'-0" height or leaf width exceeding 8'-0": 1.90" O.D. pipe, 2.72 pounds per linear foot.
3. 12'-1" to 20'-0" height: 2.375" O.D. pipe, 3.65 pounds per linear foot.
4. Assemble gate frames by welding. Install mid-height horizontal rails on gates over 10'-0" in height. When the width of a gate leaf exceeds 10'-0", install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.

J. Swing Gate Hardware

1. Hinges: Non-lift type, offset to permit 180 degree swing and of a suitable size and weight to support the gate. Provide 1½ pair of hinges for each leaf over 6' high.
2. Latch: Heavy, industrial type latch complying with ICC A117.1 with padlock eye for single gates 10 feet wide or less. Drop bar type with keeper for double gates and single gates over 10 feet wide complete with flush plate set in concrete. Drop bar length shall be 2/3 the height of the gate. A padlock eye shall be an integral part of the latch construction.
3. Holdbacks for Vehicular Gates: Type which automatically engages the gate leaf and holds the gate in the open position until manually released.
4. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

K. Chain Link

1. PVC Coated Fabric: Unless otherwise specified, provide 2" mesh, 9-gauge steel wires, with one piece fabric widths for fencing up to 12 feet high. The PVC coating is to be fused and adhered to galvanized wire in accordance with Federal Specification RR-F-191 H/ID, ASTM F-668 Class 2B, and ASTM F934. Coating thickness to be 7 mils.

    a. Baseball Backstops: 9 gauge, 2" mesh fabric roof system with 6 gauge, 2" mesh wire back and sides.
    b. Manufacturer: Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan or similar.
    c. Color to be black unless specifically noted otherwise on the Contract Documents.

2. Selvages: Top and bottom selvages to be knuckled unless specifically noted otherwise on the Contract Documents. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

L. Post Caps:

1. Weather tight closure cap, one cap per post.
2. Furnish caps with openings to permit passage of rail.
3. Fasteners: Tamper resistant cadmium plated steel screws.
4. PVC Coated: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan.

M. Stretcher Bars: One piece equal to the full length of the fabric, minimum cross section 3/16" by ¾". Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

N. Metal Bands (for securing stretcher bars): Steel, wrought iron or malleable iron. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

O. Hardware: Self-locking bands, tie wires and similar accessories. All hardware ends to pipe rails and other fence components must be of solid construction that prevents access to wasps and similar insects.

1. Aluminum Coated Hardware: Aluminum coating to be minimum of 0.40 ounces per square foot in accordance with ASTM F 626-96.
2. PVC Coated Hardware: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan to match color of adjacent fence components.

P. Wire Ties: PVC finish complying with ASTM A809, 0.40 ounces per square foot.

1. For tying fabric to line posts, rails, and braces: 9-gauge steel wire installed at 12" O.C.
2. For tying tension wire to fabric: 11-gauge steel hog rings at 24" O.C.

Q. Truss Rods: 3/8" diameter. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

R. Bolts and Nuts: ASTM A 307, Grade A. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

S. Concrete: Portland cement concrete having a minimum compressive strength of 2500 psi at 28 days.

T. Cold Galvanizing Compound: Single component compound giving 93% pure zinc in a dried film and meeting the requirements of DOD-P-21035A (NAVY)

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which chain link fences and gates are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the Installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the Installer.

3.2 PREPARATION

A. Clear and grub plant material along the fence line as required to eliminate growth interfering with the fence alignment. Remove all debris from the project property.

B. Do not begin installation of the fence until finish grading in area has been completed.

3.3 INSTALLATION

A. Space posts equidistant in the fence line at a maximum of 10 feet on center unless specifically noted otherwise on the Contract Documents.

B. Setting Post in Earth: Drill holes for fence footings. Set posts in the center of the hole and fill the hole with concrete. Plumb and align posts, vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above the finish grade elevation to shed water. Do not attach fabric to posts until the concrete has cured a minimum of seven days.

C. Located corner posts at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals no greater than 500 feet. On runs over 500 feet, space pull posts evenly between corner or end posts. On long curves, space pull posts so that the strain of the fence will not bend line posts.

D. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by the fencing manufacturer.

E. Install bottom and intermediate rails in one piece between posts and flush with the post on the fabric side using special offset fittings where necessary.

F. Brace corner posts, pull posts, end posts and gate posts to adjacent line posts with horizontal rails.

G. Diagonally brace corner posts, pull posts, end posts and gate posts to adjacent line posts with truss rods and turnbuckles.

H. Attach the fabric to the active playfield or security side of the fence. Maintain a 1-inch clearance above the finished grade except where indicated otherwise. Thread stretcher bars through the fabric using one bar for each gate and end post and two for each corner and pull post. Pull fabric tight so that the maximum deflection of the fabric is 2 inches when a 30-pound pull is exerted perpendicular to the center of a panel. Maintain tension by securing stretcher bars to posts with metal bands spaced at 15” O.C. Fasten fabric to steel framework with wire ties spaced 12” O.C. for line posts and 24” O.C. for rails and braces. Bend back wire ends to prevent injury. Tighten stretcher bar bands, wire ties and other fasteners securely.

1. When the fabric height exceeds 12’, overlap horizontal splices 6”at the intermediate rail and secure with wire ties spaced at 12” O.C.

I. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of the fence. Tighten nuts and cut off excess threads so no more than 1/8” is exposed. Peen ends to prevent loosening or removal of nuts. Secure post tops and extension arms with tamper resistant screws.

J. Install gates plumb and level and adjust for full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary. Install gate latch at 36” above finish grade to comply with ICC A117.1.

K. Wire brush and repair welded and abraded areas with one coat of cold galvanizing compound.

L. Restore disturbed ground areas to their original condition. Topsoil and seed to match adjacent areas.

3.4 ADJUSTING AND CLEANING

A. Repairs and Protection of chain link fences and gates.

1. Repair or replace broken or defective chain link fences and gates as directed by the Architect.
2. Protect chain link fences and gates from damage until acceptance of the fencing construction.

END OF SECTION 323113

SECTION 329200 - TURFS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Division 01 General Requirements and Section 01 50 00 Temporary Facilities and Controls apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Seeding.
2. Meadow grasses and wildflowers.

B. Related Sections include Section 01 50 00 Temporary Facilities and Controls for Temporary Seeding.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

C. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

B. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

C. Qualification Data: For landscape Installer.

D. Planting Schedule: Indicating anticipated planting dates for each type of planting.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn and meadow establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

C. Pre-installation Conference: Conduct pre-installation conference at the Site per Division 01 General Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

1.7 SCHEDULING

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Planting: April 1 to September 15 or as approved by Engineer.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).
   1. Water lawn at a minimum rate of 1 inch (25 mm) per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
   1. Mow grass 1 to 2 inches (25 to 50 mm) high.

E. Lawn Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.

   1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

1.9 MEADOW MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than 40 days from date of Substantial Completion.

B. Maintain and establish meadow by watering, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch.

C. Watering: Provide lawn-watering equipment to convey water from sources and to keep meadow uniformly moist.

   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
   2. Water meadow at a minimum rate of 1/2 inch (13 mm) per week for 6 weeks after planting.

PART 2 - PRODUCTS

2.1 SEED

A. Seed Species:

   1. Seed Mix #1 (Lawn Areas)
      a. Provide seed mix at a rate of 100 pounds per acre containing the following mixture:

1) Kentucky Bluegrass (20%).
2) Creeping Red Fescue (40%).
3) Perennial Ryegrass (20%).
4) Annual Ryegrass (20%).

2. Seed Mix #2 (Meadow Areas)
   a. Provide Showy Northeast Native Wildflower & Grass Mix (ERNMX-153) at a rate of 20 pounds per acre as provided by Ernst Conservation Sees, Inc. or approved equal.

2.2 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

   a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs or marshes.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 (3.35-mm) sieve and a maximum 10 percent passing through No. 40 (0.425-mm) sieve.

C. Aluminum Sulfate: Commercial grade, unadulterated.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through [3/4-inch (19-mm)] sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 PLANTING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.6 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.8 EROSION-CONTROL MATERIALS

A. Erosion-Control Blankets: per Section 01 50 00 Temporary Facilities and Controls.

2.9 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers recommended by the qualified soil testing laboratory.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding overspray.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

2. Spread planting soil mix to a depth of 4 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the rate of 3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m).

C. Rake seed lightly into top 1/8 inch (3 mm) of topsoil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

3.5 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.
2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre (15.3-kg/92.9 sq. m) dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.6 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.7 MEADOW

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the net rate as recommended by manufacturer.

C. Brush seed into top 1/16 inch (1.6 mm) of topsoil, roll lightly, and water with fine spray.

D. Water newly planted areas and keep moist until meadow is established.

3.8 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION 329200

SECTION 334100 - STORM UTILITY DRAIN PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Division 01 General Requirements, Section 31 20 00 Earth Moving, Section 31 23 33 Trenching and Backfilling, and Section 31 50 00 Excavation Support and Protection.

1.2 SUMMARY

A. This Section includes storm drainage as shown on the project drawings.

1.3 DEFINITIONS

A. HDPE: High-Density Polyethylene plastic.

B. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Shop Drawings: Include plans, elevations, details, and attachments for the following:

1. Precast concrete inlets, catch basins, and other structures, including frames, covers, and grates.

2. Drainage Piping.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 01 Requirements.

B. Do not store plastic structures, pipe, and fittings in direct sunlight.

C. Protect pipe, pipe fittings, and seals from dirt and damage.

D. Handle precast concrete inlets and other structures according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping to be closed and abandoned.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.2 PIPES AND FITTINGS

A. Corrugated PE Drainage Tubing and Fittings: AASHTO M 252, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 252, corrugated, matching tube and fittings to form soiltight joints.

B. Corrugated PE Pipe and Fittings: AASHTO M 294, Type S, with smooth waterway for coupling joints.

1. Soiltight Couplings: AASHTO M 294, corrugated, matching pipe and fittings to form soiltight joints.

C. PVC Type PSM Solid and Perforated Piping:

1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends
3. Gaskets: ASTM F 477, elastomeric seals
4. Perforations: ASTM F758 / AASHTO M278 Hole Pattern

2.3 STORMWATER INLETS

A. Yard Drain Inlets: Made with horizontal gutter opening, of materials and dimensions according to the project drawings. Include heavy-duty frames and grates.

B. Catch Basins: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to project drawings. Include heavy-duty frames and grates.

C. Drain Inlets: Made with horizontal gutter opening, of materials and dimensions according to the project drawings. Include heavy-duty frames and grates.

D. Frames and Grates: Dimensions, opening pattern, free area, and other attributes as indicated on the project drawings.

1. Material: ASTM A 536, Grade 60-40-18 minimum, ductile-iron casting.

2.4 CONCRETE

A. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water-cementitious ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.

2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, (Grade 420) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 Earth Moving and Section 31 23 33 Trenching and Backfilling.

3.2 PIPING APPLICATIONS

A. General: Include watertight, silttight, or soiltight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.

C. Gravity-Flow Piping: Use the following:

1. NPS 4 and NPS 6 (DN100 and DN150): Corrugated PE drainage tubing and fittings, silttight couplings, and coupled joints.
2. NPS 8 to NPS 15 (DN200 to DN375): Corrugated PE drainage tubing and fittings, soiltight couplings, and coupled joints in NPS 8 and NPS 10 (DN200

and DN250). Use corrugated PE pipe and fittings, soiltight couplings, and coupled joints in NPS 12 and NPS 15 (DN300 and DN375).

3.3 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:

a. Sleeve type to join piping, of same size, or with small difference in OD.
b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.

3.4 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

F. PE Pipe and Fittings: As follows:
1. Join Pipe, tubing, and fittings with couplings for soiltight joints according to manufacturer’s written instructions.
2. Install according to ASTM D 2321 and manufacturer’s written instructions.
3. Install corrugated piping according to the Corrugated Polyethylene Pipe Association’s “Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings”.

G. System Piping Joints: Make joints using system manufacturer’s couplings, unless otherwise indicated.

H. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

3.5 STORMWATER INLET INSTALLATION

A. Construct inlets to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.6 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as work progresses.

1. Place plug in end of incomplete piping at end of day and when work stops.
2. Flush piping between inlets and other structures to remove collected debris, if required by authorities having jurisdiction.

B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

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

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.

END OF SECTION 334100

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

B. Related Sections Include the Following:

1. Division 07 Sections "Self-Adhering Sheet Waterproofing" for molded-sheet drainage panels installed with subdrainage.

1.2 SUBMITTALS

A. Product Data:

1. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PVC Sewer Pipe and Fittings: meeting the requirements of AASHTO M278, Class PS46 PVC pipeing system for subsurface drainage of transportation facilities. Provide ASTM D 2729, Schedule 40, rigid PVC pipe in 4 inch diameter, with bell-and-spigot ends, for loose joints.

2.2 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earthmoving."

2.3 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earthmoving."

3.3 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.

2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
2. Lay perforated pipe with perforations down.
3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping according to ASTM D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping where indicated.

3.7 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) deep. Set top of cleanout 1 inch (25 mm) above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

3.8 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.9 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earthmoving."

1. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

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

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600